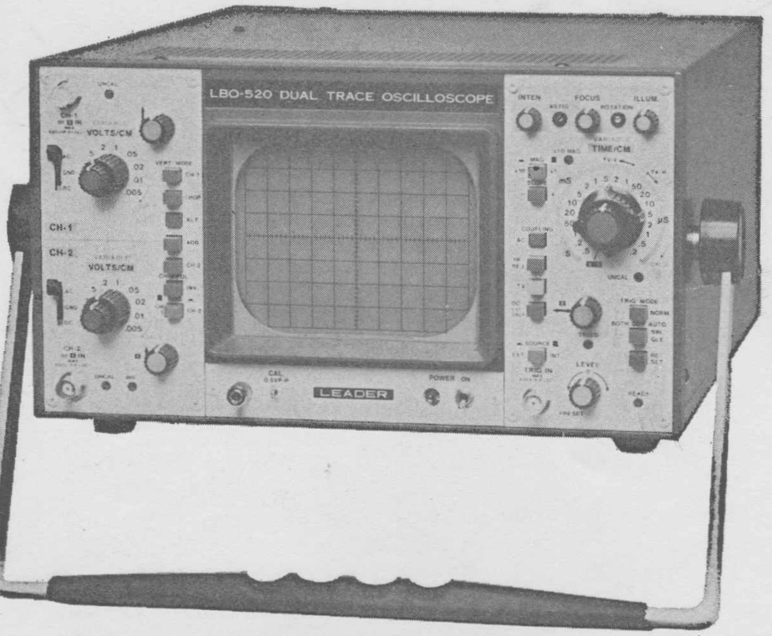
LEADER TEST INSTRUMENTS

MODEL LBO-520

DUAL TRACE/WITH DELAY LINE 5" OSCILLOSCOPE

OPERATING INSTRUCTION MANUAL



LEADER ELECTRONICS CORP.

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1. INTRODUCTION

LBO-520 is a portable oscilloscope designed for wide bandwidth, high sensitivity and high brightness.

As Vertical Amplifier has wide bandwidth of DC ~ 30MHz and high sensitivity of 5mV/cm, 27MHz CB transmission wave can be displayed clearly on the screen.

Time base providing maximum sweep speed time of 0.2μS/cm, if magnified by 10, is able to make high sweep speed at 20nS/cm and with signal delay line in the Vertical Amplifier, leading edge at high speed pulse can be easily observed, High accelerated voltage C.R.T. of 8 × 10cm effective display area and with post acceleration enables high speed pulse to be clearly displayed.

2. SPECIFICATIONS

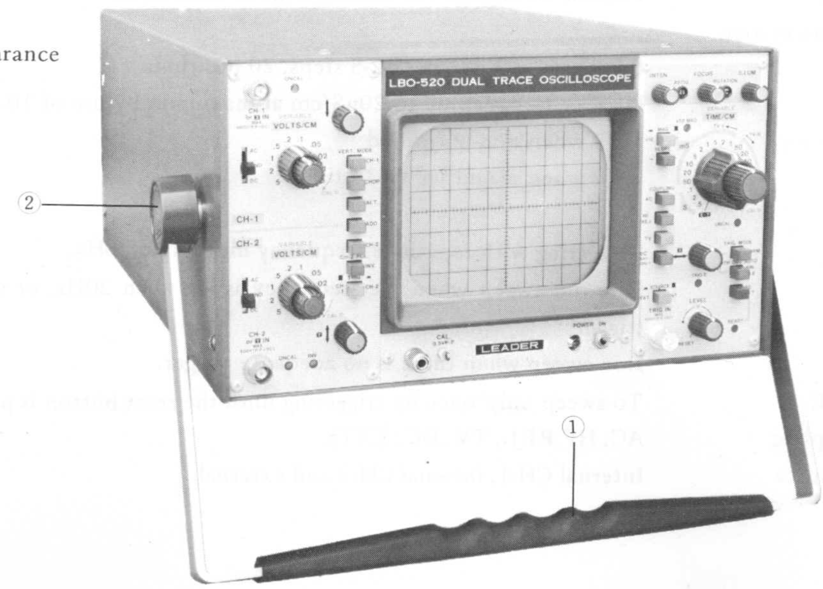
CRT Display	
Effective display area	8 cm (vert.) × 10cm (horiz.)
Acceleration voltage	4.8 kV/1.2kV
Beam rotator	Possible to control the tilt of horizontal trace line caused by the earth magnetism from the panel.
Vertical deflection system	
Frequency Bandwidth	DC to 30MHz, –3dB 8cm ret.
Sensitivity	5mV/cm – 5V/cm, 1-2-5 steps, 10 positions Continuous adjuster with warning lamp of non-calibration.
Calibration accuracy	± 3%
Input impedance	1MΩ, 35pF
Maximum input	600V (DC + AC peak)
Sweep mode	CH-1: Channel 1 only CH-2: Channel 2 only ALT: Channels 1 and 2 alternately CHOP: Channels 1 and 2 switched at approx. 250kHz in switching frequency repeatedly. ADD: Channel 1 and channel 2 are added
Rise time	11.7 nS
Signal delay time	Possible to observe the leading edge of waveform.
Horizontal deflection system	
Sweep time	0.2μS/cm – 0.5S/cm, 1-2-5 steps, 20 positions Possible to sweep up to 20nS/cm at maximum by use of 10-time magnifier.
Calibration accuracy	± 3% when non-magnified ± 5% when magnified to 10 times.
Triggering	
Mode AUTO	Triggering with repetitive frequency more than 20Hz. Free-run sweep when the frequency is less then 20Hz, or when there is no adequate trigger.
NORM	Non-sweep when there is no adequate trigger.
SINGLE	To sweep only once by triggering until the reset button is pushed.
Triger signal coupling	AC, HF REJ., TV, DC (EXT)
Trigger signal source	Internal CH-1, internal CH-2 and external.

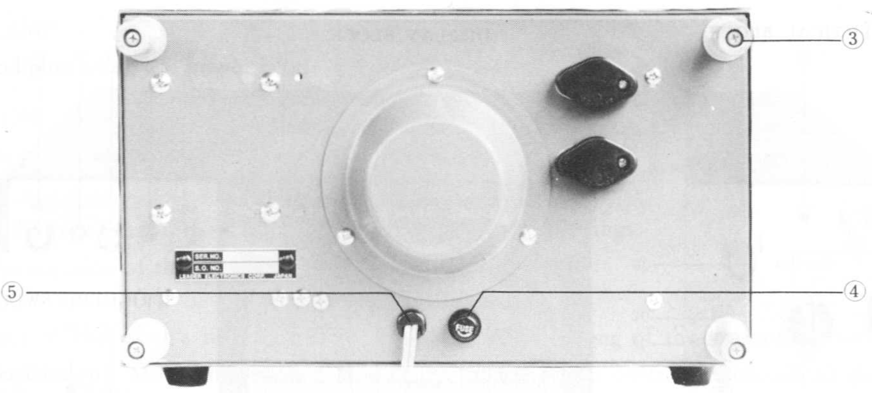
External input terminal	Approx. 1MΩ, approx. 30pF.
	Max 600V (DC + AC peak)
Trigger polarity	Positive (+) or negative (−)
Trigger sensitivity	(internal) 0.5cm. 20Hz − 30MHz (AC)
	(external) 0.5Vp-p, DC or 20Hz − 30MHz.
X-Y mode (CH-1 X-axis, CH-2 Y-axis)	
X-Y deflection sensitivity	(Common to both X and Y axis)
	5mV/cm − 5V/cm, 1-2-5 steps, 10 positions, (when horizontally non-magnified)
X-axis frequency bandwidth	From DC to 1MHz, −3 dB. (For Y-axis, same as CH-2)
Phase difference	Within 3° at 100kHz
Calibration voltage	
Output voltage	0.5Vp-p ±3%
Waveform	Approx. 1kHz Square wave
Others	
Power supply	50/60Hz 100V ± 10%
	(Possible to supply 100V, 115V, 200V, 215V and 230V by changing the tap wiring of transformer)
Power consumption	50W at 50Hz 100V
Size	290(W) × 160(H) × 375(D) mm
Weight	8.5 kg
Accessories	1/1, 1/10 changeable probes,
	LP-16X 2
	BNC Terminal adapters 2
	Slow blow fuse 1
	Operation Instruction 1

3. DESCRIPTION OF PANEL FUNCTIONS

The numbers enclosed with circles in this instruction manual refers to the control knobs and function switches of the LBO-520.

3-1 General appearance

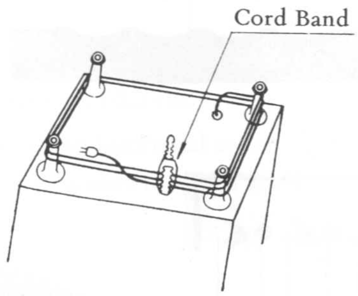




① Hand carrier
The hand carrier can also be used as a stand.

② Hand carrier stopper
Locks the hand carrier at 22.5°. Firmly press in each stopper ② with both hands, the hand carrier will be unlocked and rotate freely. Upon release the hand carrier will revert to locked position.

③ Legs for vertical viewing and AC cord winding
These are legs for vertical viewing and AC cord winding convenience.
To store or shorten AC cord wind around legs.

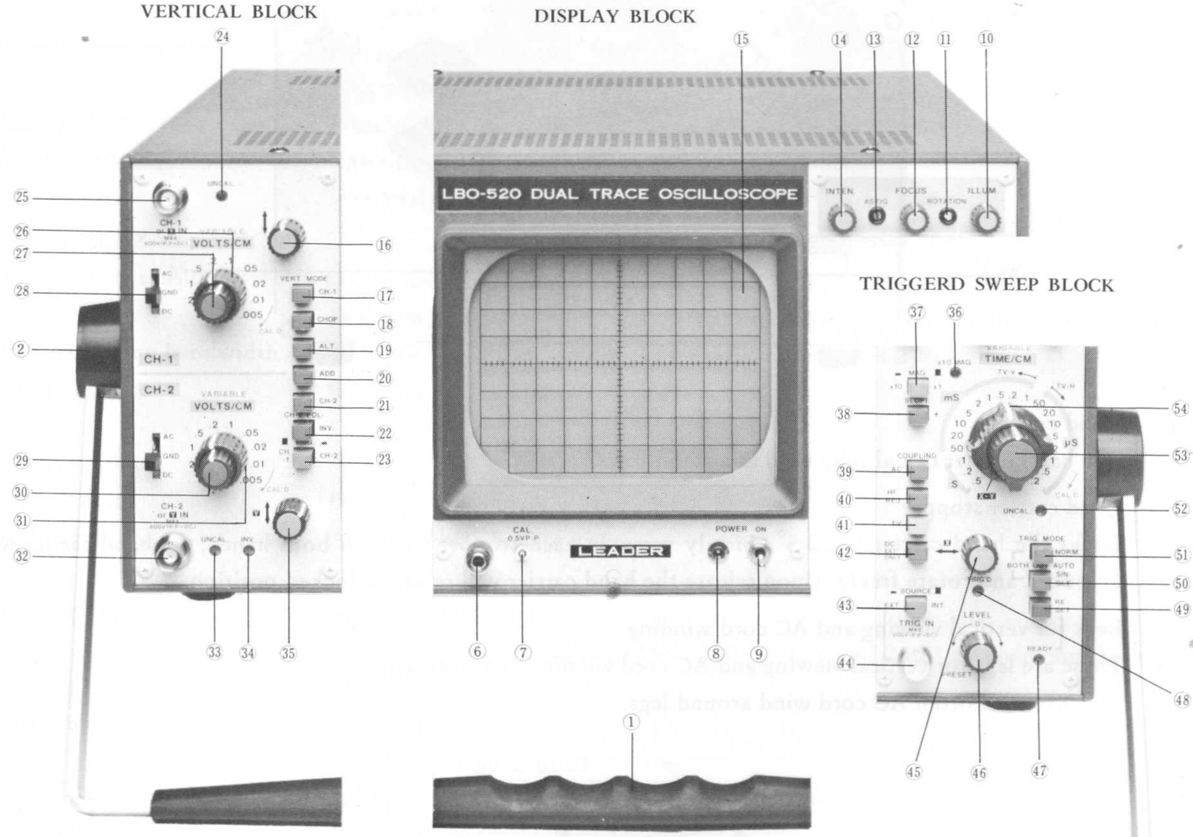


④ Fuse
The fuse is released when the cap is rotated counterclockwise. Note the type and rating of the fuse used. (Refer to Section 4-1).

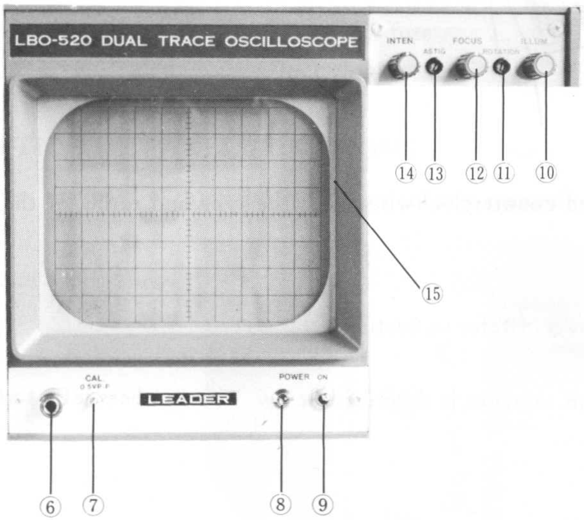
⑤ AC cord
Observe caution relative to the rated line voltage. (Refer to Section 4-1).

3-2 General Arrangement Diagram of Control Knobs

The arrangement of all control knobs and function switches is described below. The numbers refer to their placement as shown on the panel drawings.



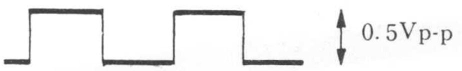
3-3 Display Block



⑥ Ground terminal

⑦ CAL 0.5Vp-p (Calibration wave)

Signal output terminal for amplitude and probe calibration. The frequency is approx. 1kHz.



⑧ PILOT LAMP

The lamp lights when the power is on.

⑨ POWER ON

Turns the power on or off.

⑩ ILLUM.

Provides illumination on the scales for easy scale and trace readings.

Clockwise rotation of the knob increases scale line brightness.

⑪ ⊘ ROTATION

The effect of the earth's magnetic field may cause slight tilting of the horizontal traces due to placement of the instrument. Move the traces to the center of the scales on the screen, adjust the ROTATION knob with a screw driver in the direction that cause the traces to become parallel with the horizontal scales.

⑫ FOCUS

Adjusts focus grid voltage for clarity of the display.

⑬ ⊘ ASTIG.

If a clear image can not be obtained with the FOCUS knob alone, adjust the ASTIG knob by means of a screw driver alternately with the FOCUS knob for proper clarity of image. (Normally, this adjustment is seldom required).

⑭ INTEN

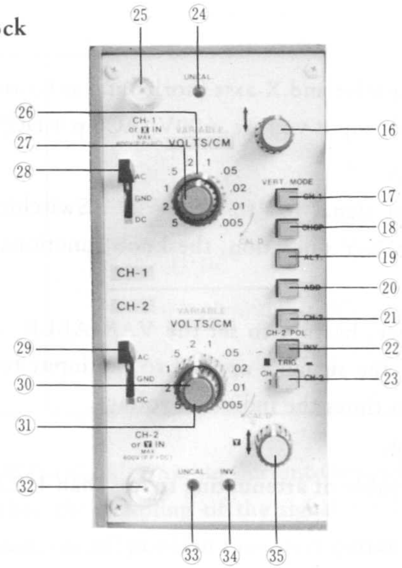
Adjusts pattern luminance or brightness on the screen. With the knob turned clockwise, the pattern luminance or brightness increases, with the knob turned counterclockwise, the luminance or brightness decreases.

⑮ Scales and Blue Filter

Scales are provided on the surface of the screen of 8 cm. high and 10 cm wide. Moreover, in the center, sub-scales are provided at intervals of 0.2 cm.

The vertical voltage sensitivity and horizontal sweep time are adjusted in accordance with these scales. The vertical voltage sensitivity corresponds to VOLTS/cm, and the horizontal sweep time to TIME/cm and scales.

3-4 Vertical Block



⑯ ↕ (Vertical position adjustment)

With the knob turned clockwise, the waveforms of CH-1 move upward. When the knob is turned counterclockwise, the waveforms move downward.

⑰ CH-1

Only the input signal applied to CH-1 is displayed. If performing trigger with the internal signal, set the TRIG. selector switch ㉓ at ▌ (push-OUT).

⑱ CHOP (Dual trace rapid switching display)

Square wave of about 250kHz performs high-speed switching to display dual traces. Use the switch when horizontal sweep time is 0.5ms/cm or less.

⑲ ALT. (Dual trace alternate display)

CH-1 and CH-2 are alternately displayed every sweep. Use the switch when horizontal sweep time is 0.5ms/cm or more.

⑳ ADD. (Addition)

The input signals of CH-1 and CH-2 are algebraically added and displayed. When the CH-2 polarity inversion switch ㉒ is at INV., subtraction is accomplished.

㉑ CH-2

Only the signal applied to CH-2 is displayed. If performing trigger with the internal signal, set the TRIG. selectors switch ㉓ at ▄ (psuh-IN).

㉒ ▌ CH-2 POL. ▄ INV. (CH-2 Polarity inversion switch)

Set at ▌ (push-OUT) for normal operation. At INV. (inversion) ▄ (push-IN), the polarity of the signal applied to CH-2 will be inverted. That is, the upper part will become negative and the lower part, positive, INV. lamp ㉞ will light.

㉓ ▌ TRIG. ▄ CH-1/CH-2

This is a switch for selecting the internal trigger signal for CH-1 or CH-2. On dual trace operation, it performs trigger by switching to CH-1 or CH-2. In addition, on single trace operation, the switch selects the channel that displays waveforms on the screen.

On the other hand, when the measuring signal is applied to CH-1 to provide CH-1 display and the trigger signal is applied to CH-2 with this switch at TRIG. CH-2, external trigger at high sensitivity can be used.

㉔ UNCAL Lamp

When the red knob VARIABLE ㉗ of CH-1 is not turned fully clockwise to CAL'D, VOLTS/cm ㉖ ranges are not calibrated and the UNCAL lamp lights.

㉕ CH-1 or [X] IN

This is an input terminal for use with the CH-1 vertical amplifier and X-axis (horizontal axis) amplifier during X-Y operation. Caution not to exceed maximum permissible input voltage, 600V (ACp-p + DC).

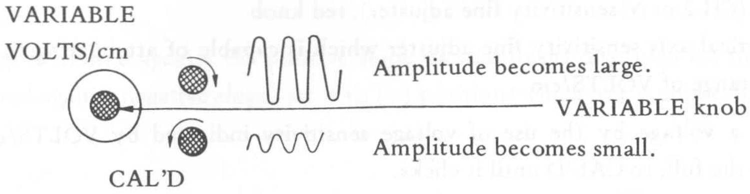
㉖ VOLTS/cm (CH-1 or [X] sensitivity switch), black knob

This is a knob for switching the sensitivity of the input signal fed to CH-1 ㉕. Switching action is accomplished in 10 steps from 5mV/cm to 5V/cm. On X-Y operation, the knob functions to change the ensitivity of the X-axis.

To measure by the use of the indicated voltage sensitivity, be sure to set the VARIABLE ㉗ (red knob) to CAL'D by turning it fully clockwise until it clicks. If the signal is applied to the input terminal ㉕ by the use of a 1/10 low capacitance probe, the values are ten times the indicated voltage.

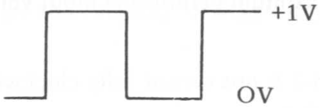
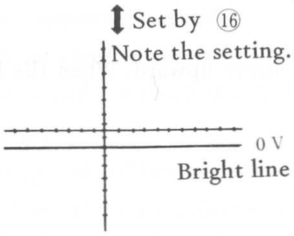
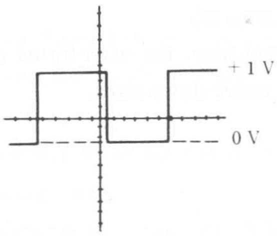
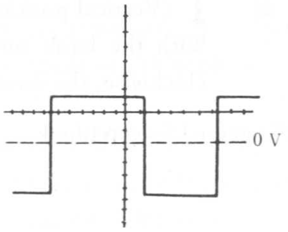
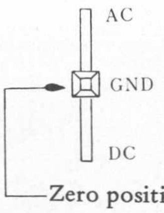
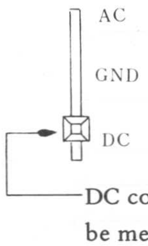
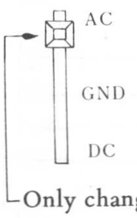
㉗ VARIABLE (CH-1 or [X] sensitivity fine adjuster), red knob

This is a vertical axis sensitivity fine adjuster which is capable of attenuating to less than 1/2.5 by indication of each range of VOLTS/cm.



When measuring a voltage by the use of voltage sensitivity indicated by VOLTS/ cm , turn the VARIABLE clockwise to the full position, that is, to ⟩ CAL'D until it clicks.

㉘ AC-GND-DC (Alternating Current-Ground-Direct Current Switch)
Switches the coupling of the signal fed to the vertical axis input ㉕ . DC coupling is obtained on the DC position, on AC position the direct current component is blocked by a capacitor. The GND position grounds the input of the amplifiers and opens the input terminal ㉕ . The following table illustrates a display at each switching position (AC-GND-DC).

Input signal	 Symmetrical square wave		
Waveform and its position on the screen			
Position of switch ㉘	 Zero position (OV)	 DC content can be measured	 Only change in A C content can be measured.

㉙ AC-GND-DC (Alternating Current-Ground-Direct Current Switch)
Switches the coupling of the signal fed to the vertical axis input ㉜ . DC coupling is obtained on the DC position, on AC position the direct current component is blocked by a capacitor. The GND position grounds the input of the amplifiers and opens the input terminal ㉜ . An example of display at each switching position (AC-GND-DC) is shown by the table at switch ㉘

(30) VARIABLE (CH-2 or [Y] sensitivity fine adjuster), red knob

This is a vertical axis sensitivity fine adjuster which is capable of attenuating to less than 1/2.5 the indication of each range of VOLTS/cm .

To measure a voltage by the use of voltage sensitivity indicated by VOLTS/cm , turn the VARIABLE clockwise to the full, to CAL'D until it clicks.

(31) VOLTS/cm (CH-2 or [Y] sensitivity switch), black knob

This is a knob for switching the sensitivity of the input signal fed to CH-2 (32) . Switching action is accomplished in 10 steps from 5mV/cm to 5V/cm . On X-Y operation, the knob functions to change the sensitivity of the Y-axis.

To measure by the use of the indicated voltage sensitivity, be sure to set the VARIABLE (30) (red knob) to CAL'D by turning it fully clockwise until it clicks. If the signal is applied to the input terminal (32) by the use of a 1/10 low capacitance probe, the values are ten times the indicated voltage.

(32) CH-2 or [Y] IN

This is an input terminal for use with the CH-2 vertical amplifer and Y-axis (vertical axis) amplifier during X-Y operation. Caution not to exceed maximum permissible input voltage, 600V (ACp-p + DC).

(33) UNCAL Lamp

If the red knob VARIABLE (30) of CH-2 is not turned fully clockwise, to CAL'D, VOLTS/cm (31) ranges are not calibrated and the UNCAL lamp lights.

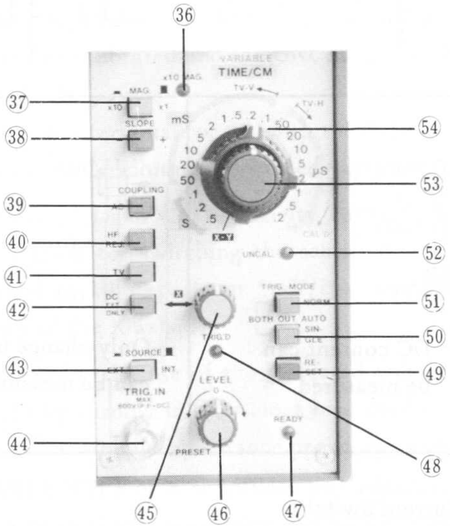
(34) INV. Lamp

This is a lamp to indicate that the polarity of the CH-2 amplifier is inverted when button (22) is depressed.

(35) ↕ (Vertical position adjustment)

With the knob turned clockwise, the waveforms of CH-1 move upward. When the knob is turned counterclockwise, the waveforms move downward.

3-5 Triggered Sweep Block



(36) x10 MAG. Lamp

When the horizontal magnifier is expanded ten times by the magnifier switch (37) , lamp lights.

(37) MAG. x1/x10 (Horizontal magnifier)

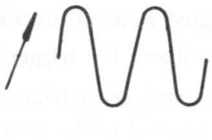
Normal position is x1, (push-out). x1 is also used on X-Y operation.

If set to x10, (push-in), waveforms will be expanded ten times horizontally.

㊳ ▮ SLOPE ▬ +/−

If triggered sweep is desired against the positive slope of waveforms displayed on the screen, set this switch to (+) position, and against negative slope, set it to (−) position, whichever is applicable.

Positive slope

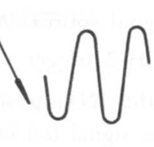


SLOPE

▮ +

(Push-out)

Negative slope



SLOPE

▬ −

(Push-in)

The switches ㊴ to ㊸ select the coupling of trigger signals.

㊴ AC

Trigger signals are coupled through a capacitor. The DC component is removed and signals of 20Hz or less are attenuated. Generally, the switch is used at this position.

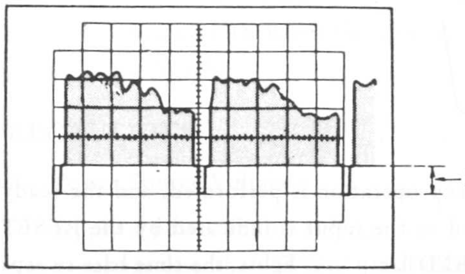
㊵ HF REJ. (High frequency rejection)

Trigger signals are coupled through the wave filter. Signals except 20Hz to 10kHz are attenuated. This switch is used when it is difficult to obtain stable triggering due to the presence of noisy signals or CHOP pluses.

㊶ TV (Image signal)

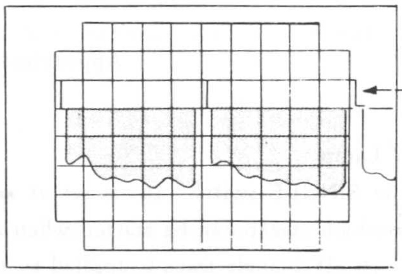
Extracts the trigger signal from composite T.V. or V.T.R. image signals (video signals) and provides triggering with the T.V. vertical trigger signal when the sweep time ㊹ is in the range of 0.1ms/cm or less and with the horizontal trigger signal in the range of 50μs/cm or more. At this point, it is necessary to select the SLOPE ㊳ as illustrated below in accordance with the polarity of the video signals.

Triggering pulse polarity of image signals and selection of SLOPE



Negative polarity

SLOPE −



Positive polarity

SLOPE +

⑫ DC (EXT ONLY)

Triggers all components of trigger signals from external sources, including direct current. This switch is especially suitable for use in triggering under ultra-low speed phenomena.

When source of ⑬ is atINT position, triggering is to be obtained from 2 Hz (AC).

⑬ SOURCE, INT./EXT.

Selects trigger signal source. At INT., part of the signal taken from the vertical amplifier selected by the TRIG CH-1 or CH-2 trigger selector switch ㉓ is utilized for triggering. Normal operation is performed with switch at the INT. position. EXT. position is used with triggering is desired when another signal triggered with the signal fed into the vertical input is applied to the EXT. TRJG. INPUT terminal ⑭

⑭ EXT. TRIG. IN (External trigger input terminal)

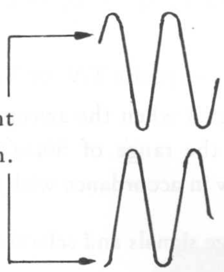
This is terminal for applying trigger signals from external sources. To provide appropriate triggering, the input of 200mVp-p to 20Vp-p is required. Do not exceed maximum input voltage, 600V (ACp-p + DC).

⑮ X ⟷ (Horizontal position adjustment)

Pattern moves to the right with clockwise rotation and to the left with counterclockwise rotation. Both fine and coarse adjustments can be made simultaneously by this one control, assuring accurate adjustments even when the horizontal magnifier (MAG. x10) is used. On X-Y operation, adjust the horizontal position of the X-axis (CH-1) by this control.

⑯ LEVEL (Trigger level adjustment)

Stabilizes the starting point of trigger sweep at a proper level. If the fixed value is taken off the complex portion of the waveform under observation, the lamp ⑱ will go out and triggered sweep will cease.



PRESET (Point where it clicks when turned fully counterclockwise)

The LEVEL is preset almost in the center of the waveform.

⑰ READY Lamp

When the SINGLE switch ㊿ is set at (push-in), single sweep operation is performed, and the ready state in which sweep can be started when a single trace is applied to the input is indicated by the RESET button ㊾. If a single trace is applied to the input and the TRIG'D lamp ⑱ lights, the time base sweeps once and the READY lamp goes out at the same time as sweep stops. After that, even if the TRIG'D lamp ⑱ lights, no sweep can be performed again as long as the RESET button ㊾ is depressed and the READY lamp ⑰ does not light.

⑱ TRIG' D Lamp

This lamp indicates whether or not the triggering signal is properly converted into trigger pulses and driving sweep circuit. This is, the lamp indicates whether or not triggering is functioning

㊾ RESET

This is a button for providing the ready state in which sweep can be started during single sweep operation. The READY lamp ㊼ functions in conjunction with the RESET BUTTON.

㊿ SINGLE (Single sweep)

This switch provides proper triggering for a single shot trace or for a signal that is produced intermittently to provide a single sweep.

For camera operation, keep shutter open, make certain that the READY lamp ㊼ has gone out. Then, close the shutter and take a photograph of the single trace.

In addition, if the sweep is extremely low, visual observation can be made.

51 NORM

Use of this switch enables the applied triggering signal to start sweep at the same time as the TRIG 'D lamp ㊽ lights.

㊿-51 BOTH OUT AUTO (Auto free run)

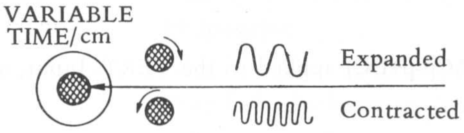
When both switches are set at ▙ (push-out), sweep free-runs automatically and shows a trace line when the TRIG 'D lamp ㊽ is not lit (with no input, for example). This type of operation is convenient for checking the zero volt position of the input signal. Automatic triggering of sweep is accomplished at the same time as the TRIG 'D lamp ㊽ lights.

52 UNCAL Lamp

When the VARIABLE 53 (red knob) is not turned fully clockwise, to the CAL'D position, no calibration can be performed with the TIME/ cm 54 , and, therefore, the UNCAL lamp lights.

53 VARIABLE (Fine adjustment of sweep time), Red knob

This is the fine adjuster for sweep time (main sweep) 54 . When measurement is made by the use of the indicated time, set the VARIABLE to ⟩ CAL'D by turning it fully clockwise until it clicks.



54 TIME/cm (Time change switch)

This is Sweep-Time change switch. $0.2\mu S/cm \sim 0.5S/cm$ can be changed in accordance with your requirements. When making measurements which the time indication, turn variable knob of 53 clockwise to the full CAL'D. When the switch is set to (X-Y) position, X-Y Oscilloscope works with CH-1 as X axis and CH-2 as Y axis.

4. PRECAUTIONS

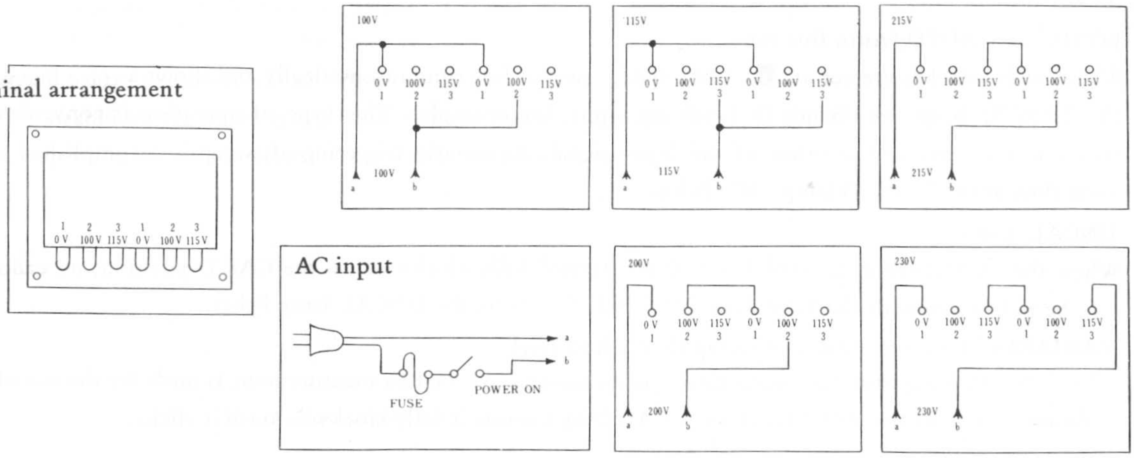
4-1 Power Source Voltage

Apply a power source voltage that is within $\pm 10\%$ of the rated values as given in the table below. Operation with a voltage less than 10% of rated value may result in improper performance of the LBO-520, and a voltage more than 10% of rated value may damage power supply circuitry.

Rated Voltage Values	Applicable Voltage Ranges	Fuse
100V	90 – 110V	1A
115V	104 – 126V	Slow Blow
200V	180 – 220V	
215V	194 – 230V	0.5A
230V	207 – 253V	Slow Blow

The built-in power transformer has taps of 100, 115, 200, 215, 230V. To make the instrument suitable for a local line voltage, rearrange the wiring of the transformer in accordance with the examples depicted below. The rating of the fuse used must be as shown in the above table.

Terminal Arrangement and Wiring Diagram of the Power Transformer

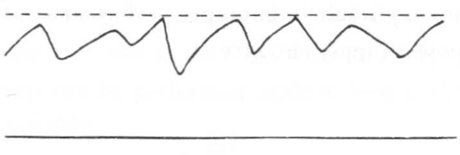


4-2 Signal Input

A voltage higher than 600V (ACp-p+DC) applied to the VERT. Input, or Trig. Input or the low capacitance probe may damage circuit components.

Vertical input terminal	INPUT ㉕ , ㉜	MAX 600V (ACp-p + DC)
External trigger signal input terminal	TRIG. IN ㊹	”
Probe input (LP-16)		

The value of 600V (ACp-p + DC) is shown in the following figure.



4-3 **Operation in a Powerful Magnetic Field**

Operation in a powerful magnetic field will cause distortion of waveforms or make traces tilt excessively. Special care should be exercised when operating the instrument close to machinery or equipment using a large transformer.

4-4 **Operation in a Hot and Humid Place**

This instrument is designed to operate in a temperature range of 0°C to +40°C and humidity range of 10 to 90%. Operation in severe environment may shorten the life of the instrument.

4-5 Intensity

A burn-resisting fluorescent material is used in the cathodes ray tube. If the cathode ray tube is left with a bright dot or bright line, or with unnecessarily raised intensity, its fluorescent screen may be damaged. When observing waveforms, therefore, the intensity should be maintained at the minimum necessary level. If the instrument is left on for extended periods, lower the intensity and obscure the focus.

5. Fundamental Operation Instructions

The fundamental operation for observing waveforms with the Oscilloscope LBO-520 are described below.

5-1 Preparation

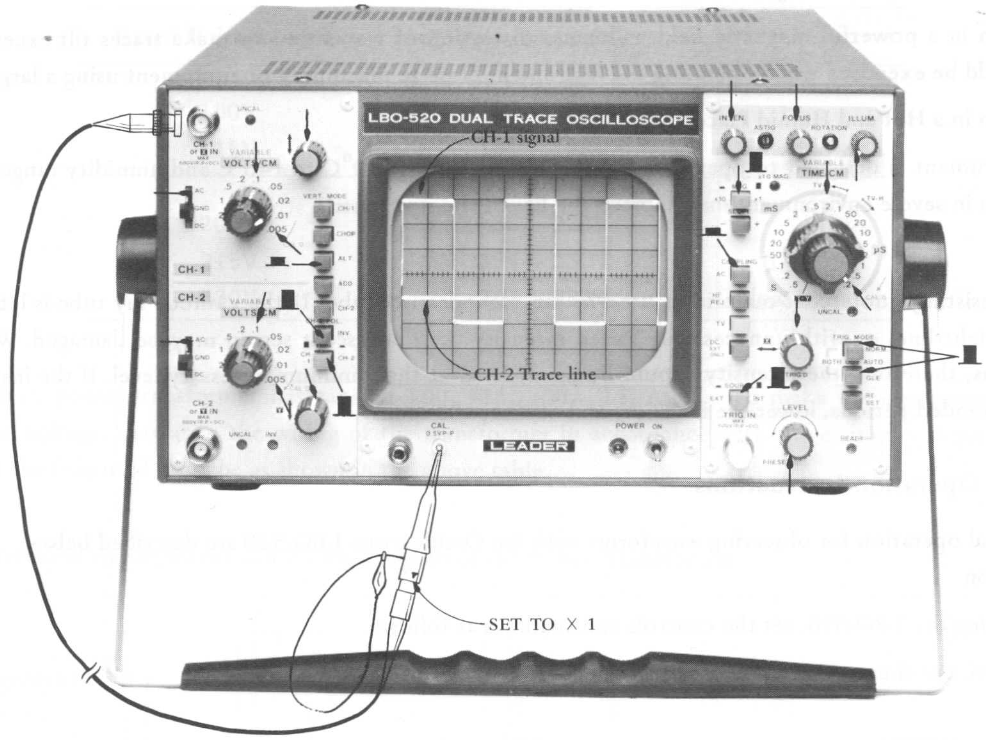
Before using the LBO-520, set the controls and switches as follows.

In addition, use these settings when checking proper operation of the instrument.

1. INTEN . ⑭	Midposition
2. FOCUS ⑫	Midposition
3. ILLUM. ⑩	Turn fully counterclockwise
4. ⬍ ⑯ , ㉟	Midposition
5. VOLTS/cm . ㉖ , ㉛	0.1
6. VARIABLE ㉗ , ㉚	Turn fully clockwise to ⟩ CAL'D
7. AC-GND-DC ㉘ , ㉙	AC
8. VERT MODE ⑲	ALT.
9. CH-2 POL. ㉒	■ (push-out), (NORM.)
10. ⬌ ㊺	Midposition
11. MAG. X1/X10 ㊲	X1
12. VARIABLE ㊸	Turn fully clockwise to ⟩ CAL'D
13. TIME/cm . ㊹	0.2ms/cm.
14. TRIG. CH-1/CH-2 ㉓	CH-1 (■ : push-out)
15. SLOPE +/− ㊳	+ (arbitrary)
16. COUPLING ㊴	AC
17. SOURCE EXT./INT. ㊸	INT. (■ push out)
18. LEVEL ㊻	Turn fully counterclockwise until locked, PRESET
19. TRIG. MODE ㊿ , 51	■ for both switches, BOTH OUT AUTO

After all settings are made, set the POWER switch ⑨ at ON. After about 30 seconds, two traces will appear on the screen. Adjust the INTENSITY ⑭ and FOCUS ⑫ controls for a clear display of the traces.

20. Connect the attached probe to CH-1 ㉕ and CAL ⑦ terminals. At this time, the probe should be at X1. For use of the probe, refer to Section 5-3; "How to Use a Low-capacity/Direct Probe."



Front Panel

5-2 Check of Gain by Calibrated Waves

After all settings are made as shown in Section 5-1, (Refer to "Front Panel Diagram.") ascertain that a square wave with an amplitude of 5 cm . is displayed on the screen.

This indicates that the instrument is operating properly.

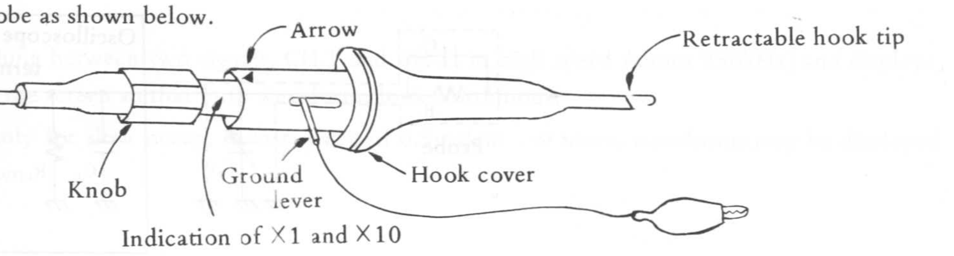
5-3 How To Use a Low-Capacity/Direct Probe

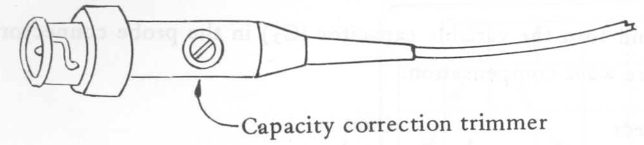
The LP-16X Probe is an extremely well designed, high-performance probe equipped with X1 and X10 switching functions.

5-3-1 Specifications

Maximum input voltage	250Vrms or 600V DC
1-1 At X10	
Input resistance	10MΩ (connected to oscilloscope of 1MΩ in input resistance)
Input capacity:	25pF or less
Correction range:	Oscilloscope with input capacity 20 – 40pF
Attenuation factor:	1/10 ±2%
Frequency range:	DC – 40MHz
1-2 At X1	
Input resistance:	1MΩ (connected to oscilloscope of 1MΩ in input resistance).
Input capacity:	250pF or less (connected to oscilloscope of 50pF or less)
Frequency range:	DC – 5MHz

5-3-2 Use the low capacity probe as shown below.





Turn the knob and hook cover to the required position to set the arrow to X1 or X10.

The knob and hook cover may be turned in any direction, but care must be used not to disconnect the ground cover that holds the hook cover in place by an internal spring, which could loosen or break and disappear.

2-1 Measurement at X10

The probe exhibits high resistance and low capacity at X10. However, the input voltage is attenuated to 1/10, and, therefore, this must be accounted for in voltage measurement.

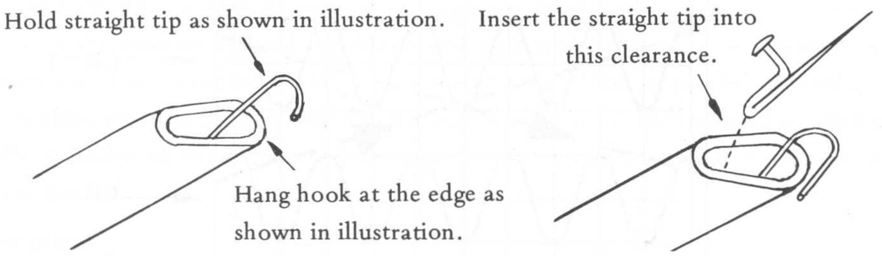
Measured voltage = Sensitivity of oscilloscope V/cm . X screen amplitude cm X 10

At X10, it is necessary to correct the pulse characteristic by adjusting the capacitor in the probe for flat top of the square wave calibration voltage (See 5-3-3).

2-2 Measurement at X1

This probe maintains high sensitivity in the X1 position so that it may be used directly with the oscilloscope. However, the input capacity is large approx. 250pF, and it is necessary to take this into account when making measurements.

2-3 How to insert the straight tip in probe.

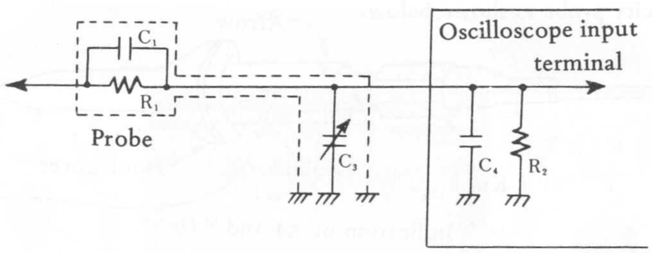


The straight tip is extremely convenient when testing points on printed circuit boards.

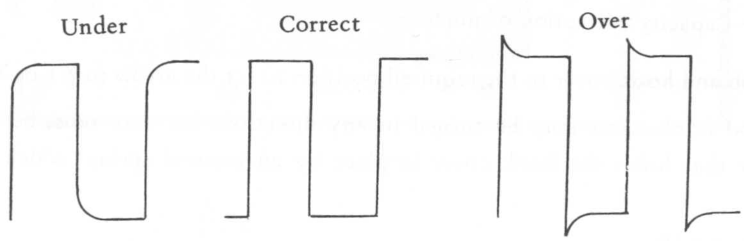
5-3-3 Adjustment of Probe

When observing the signal waveforms of high impedance circuit, the operation of the signal source and waveforms on the screen are liable to change due to the input impedance of the oscilloscope, parallel capacity of a coupling line, induction noise and other effects, leading to measurement error. The use of a low-capacity probe avoids these effects. A low-capacity probe of 10:1 attenuation type such as the LP-16X or LP-8X should be used for high impedance circuitry measurements. Its input impedance is 10MΩ at 15pF. The basic construction of this probe is as shown below. Proper compensation may be obtained if the circuit constant is adjusted in such a way that the following equation will hold:

$$R_1 \times C_1 = R_2 \times C_2, (C_2 = C_3 + C_4)$$



To adjust the probe, connect as shown below and turn the variable capacitor (C_3) in the probe connector using a small screw driver, to provide proper square wave compensation.

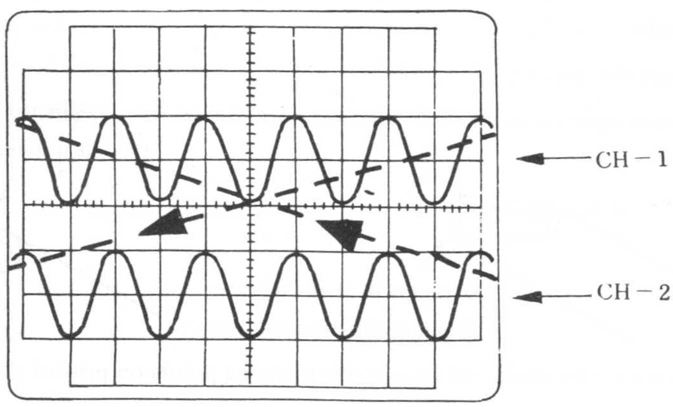


5-4 Dual Trace Measurement

Two vertical axis input circuits are provided in this instrument, and the waveforms of the two input signals are alternately shown on the screen by means of an electronic switch. However, since there is only one horizontal sweep circuit, it is not possible to have two synchronized or locked-in waveforms of two unrelated, independent input signals simultaneously on the screen. Two different methods are available for alternately switching of two signals making use of the electronic switch.

5-4-1 ALT. (Alternation)

ALT. (Alternation) serves to show two signals, CH-1 and CH-2, alternately sweep by sweep.



Two signals are alternately displayed on the screen as shown. In this mode of operation, the simultaneous observation of two waveforms is not possible if slow sweep of 0.5ms/cm or less is employed. The CHOP position must be used for slow sweep.

Notes: 1. The dotted lines shown in the above figure do not appear on the screen.

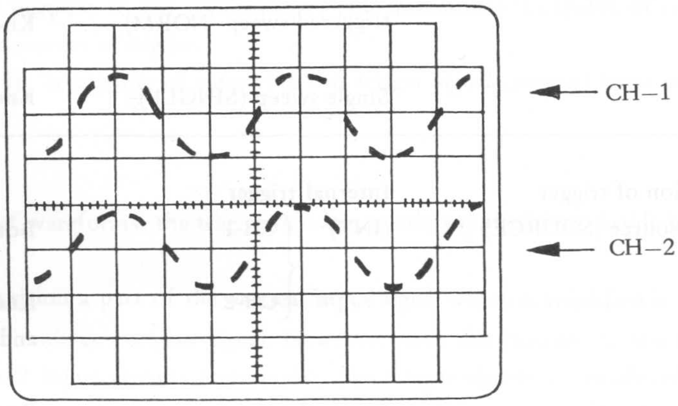
2. The comparison and observation of two independent phenomena from one source are not possible.

3. If no signal is fed to CH-2 while the TRIG. switch ㉓ is set for CH-2, triggering will not take place even though a signal is fed to CH-1.

5-4-2 CHOP

CHOP performs switching between two signals, CH-1 and CH-2, in high speed (about 250kHz) and displays the two waveforms on the screen so that both waveforms look continuous.

CHOP is applied mainly for slow sweep. In fast sweep of 0.5ms/cm . or more, waveforms may be displayed in broken lines as shown.



5-5 Precautions on Direct Connection and Using a Probe

Two different methods are available for applying signals. One is to connect a lead wire or the like to the input terminal of the oscilloscope directly, and another is to use a probe.

When viewing a small signal in a circuit having high signal source impedance, error is liable to occur in measurement due to the effect of parallel capacity or induced noise in the input cable. The following precautions should be observed to avoid false readings. Generally, with the exception of a low-impedance circuit, the use of a lead wire should be avoided as far as possible. That is, use X1 of the attached probe or a shielded wire such as coaxial cable. If a lead wire other than the probe or shielded wire is used, make the lead as short as possible. When using a shielded wire in a circuit having high impedance, attention should be paid to the loading effects of the sum of the input capacity of the oscilloscope and the distributed capacity of the probe or shielded wire on the signal source. The input terminal of the oscilloscope has a capacity of about 35pF in parallel with 1MΩ. In addition, the direct probe has a distributed capacity of about 250pF, and the coaxial shielded wire 60 to 70pF per meter. If the effect of this parallel capacity on the high impedance signal source can not be ignored. The use of the low capacity X10 probe is recommended.

Low-capacity probe

To avoid many ill effects by direct connection, use a low-capacity probe (X10) as much as possible. When this probe is used, input impedance is 10MΩ, 25pF, thus making it possible to reduce the loading effects upon the signal source to a great extent. However, when the probe is used at X10, the input signal is attenuated to 1/10, this must be taken into account in all measurements.

5-6 Ground Connection

For ground connection, use the shortest possible wire as described in Section 5-5.

When using a probe, connect to a ground point close to the signal source, and use the probe ground wire.

5-7 Triggering to Waveforns

The most important factor in operating the LBO-520 is to lock and display waveforms properly before measuring them with the oscilloscope.

To make the most use of the triggering capacity of this instrument, a proper method of operation is described below, taking waveforms as an example. In addition, the following procedures describe how to obtain proper triggering. For details, refer to 5-7-1 through 5-7-4.

1. Model of triggered sweep (TRIG. MODE)	Automatic sweep (AUTO)	Both knobs (50) and (51) at █
	triggered sweep (NORM)	Knob (51) at ▂
	Single sweep (SINGLE)	Knob (50) at ▂
2. Selection of trigger signal source (SOURCE)	Internal trigger (INT) CH-1	Both knobs (23) and (43) at █
	CH-2	Knob (23) at ▂ and knob (43) at █
	External trigger	Knob (43) at ▂
3. Coupling of trigger signals (COUPLING)	AC Coupling (AC)	Knob (39) at ▂
	Rejection of high frequency (HF REJ.)	Knob (40) at ▂
	TV Signal (TV)	Knob (41) at ▂
	DC Coupling (DC)	Knob (42) at ▂
4. Selection of triggering position	Stabilization of starting point (LEVEL)	Adjust knob (46)
	Slope of waveforms (SLOPE)	Knob (38) at +/−

To observe simple waveforms, set both switches (23) and (43) at █ (AUTO); SOURCE switch (43) at █ (INT); TRIG. switch (23) at █ (CH-1); switch (39) at ▂ (AC); and LEVEL switch (46) at PRESET by turning it fully counterclockwise.

5-7-1 Mode of Triggered Sweep

The triggered sweep circuit of this instrument stops functioning if a trigger pulse is not produced as a sweep starting pulse. It is, therefore, necessary to select this sweep according to purpose desired.

Generally, for waveforms which have a frequency of 20Hz or more and are not complex, use AUTO triggering. At AUTO triggering, the sweep circuit is automatically placed in the free-run state when the aforementioned trigger pulse is not produced (when the TRIG 'D lamp (48) goes out), and a horizintal trace is displayed irrespective of sweep time set by the knob (54).

To remove waveforms on the screen when no input signal is applied or the trigger level is not correct, depress switch ㊿ and set it to NORM.

To observe a single trace or a display of a very intermittent signal with accurate triggering or take a photograph, select the SINGLE position which provides single sweep.

5-7-2 Selection of trigger signal source

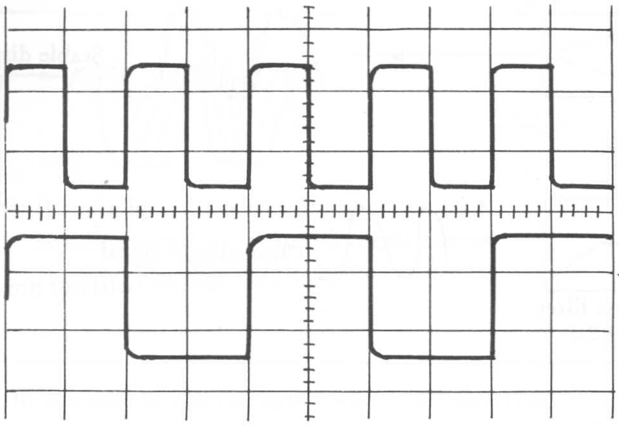
The operation called "triggering" takes place to lock waveforms being observed. It is necessary to supply a trigger signal for this purpose to the oscilloscope. This instrument is capable of selecting either internal (INT) or external (EXT) sources of trigger.

The SOURCE switch ㊸ is capable of supplying this trigger signal (source) from inside at INT and from outside at EXT.

INT Position

In normal observation of waveforms, the trigger signal is mostly supplied from inside by setting the switch at INT.

In the internal (INT) position a part of the vertical input signal which is amplified is extracted and supplied to the triggered sweep circuit as a trigger signal. However, since this instrument is a dual trace oscilloscope which is provided with 2 input circuits (terminals), two trigger signals are produced from the waveforms. It is, therefore, necessary to select from the 2 trigger signals by setting the TRIG switch ㉓ at CH-1 or CH-2. When the switch is set at CH-1, the waveforms being observed at CH-1 are triggered. At CH-2, triggering takes place of the waveforms being observed at CH-2. When the waveforms being observed at CH-1 and CH-2 are in an integer multiple relationship, stable triggering can be obtained in both channels if the frequency is the same, no matter which channel is selected. If the frequency is different, selection of the low-frequency one as a trigger signal source permits stable triggering in both channels.



Set the TRIG. switch ㉓ to the low-frequency one, to select a trigger signal source.

EXT Position

When observing composite signals or the like in which different types of signals in an integer multiple relationship are combined, the INT position permits stable triggering, if each independent signal of the composite signal can be separated and used as a trigger signal. If not, this external (EXT) position permits supplying the required trigger signal to the triggered sweep circuit directly from outside. Set the SOURCE switch ㊸ at EXT, apply a trigger signal to the TRIG. IN terminal ㊹ . Since the level of the trigger signal is constant, stable triggering can be obtained even if the level of the wavefroms being observed varies.

5-7-3 Coupling of trigger signals

Even when the trigger signal is actuating the triggered sweep circuit (the TRIG 'D lamp ⑱ is lighting), it is possible to have unstable triggering of the waveforms being observed. This is due to an unwanted signal contained in the trigger signal.

It is also possible to have the triggered sweep circuit fail to operate (the TRIGD'D lamp ⑱ does not light) even if the trigger signal is supplied. This occurs because insufficient triggering component to trigger the waveforms being observed is contained in the signal.

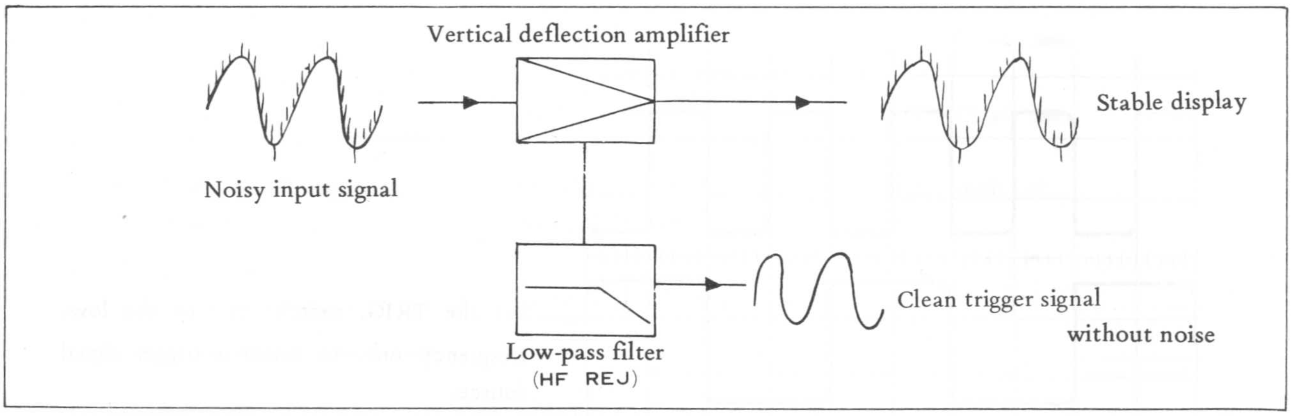
In either case, select the COUPLING switches ㊴ , ㊵ , ㊶ and ㊷ to that proper triggering is obtained.

Normal waveform observation

Set switch ㊴ at AC. At this point, the trigger signal is connected to the triggered sweepcircuit through a capacitor, thus eliminating the DC component and provides stable triggering over the whole bandwidth of 20Hz or higher. AC coupling takes place with triggering on that is not affected by a change in the DC compoent of the waveforms being observed. Signals of 20Hz or below, however, are difficult to trigger. Set switch ㊷ at DC and connect an external trigger signal from TR1G. IN terminal ㊹ to obtain stable triggering on for this condition.

Waveforms with noise

When triggering is unstable because of the presence of high frequency noise in the trigger signal despite the fact that the triggered sweep circuit is operating (the TRIG'D lamp ⑱ is lit), use HF REJ. switch ㊵ In this case, the trigger signal passes through the low-pass filter and removes high frequency noise of 10kHz or higher is removed to obtain a proper trigger signal.



T.V. (Video) composite waveforms

In T.V. video waveforms, horizontal and vertical triggering components are combined. It is, therefore, very difficult to apply triggering to the horizontal component or vertical component. In this case, set switch ㊶ at TV, and this will automatically select a horizontal trigger signal and vertical trigger signal and obtain stable triggering. However, if the sweep time set by the switch 54 is 0.1ms/cm or less, the vertical trigger signal is selected. If it is 50μs/cm or more, the horizontal trigger signals is selected.

Position SLOPE switch ㊳ according to the polarity of the composite Video signals, as shown in the explanation of switch ㊶ , Section 3-5.

Waveforms of low frequency

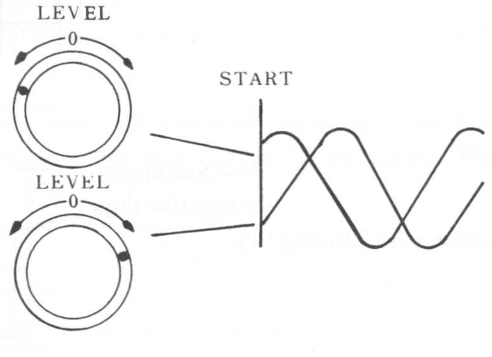
In the case of waveforms of low frequency (20Hz or below), where the triggered sweep circuit does not operate (the TRIG'D lamp ㊽ does not light) with a trigger signal of sufficient level, use the DC switch ㊷ . When source of ㊸ is at INT position, triggering is to be obtained from 2Hz (AC). If set SOURCE switch ㊸ at EXT, connect a trigger signal to the TRIG. IN terminal ㊹ so that, the trigger signal actuates the triggered sweep circuit directly (direct-current-wise), thus obtaining stable triggering. Both case, the TRIG MODE switch must be selected to push NORM ㊿51 position.

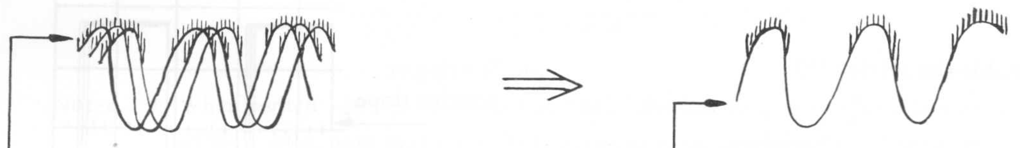
5-7-4 Selection of triggering position

In a triggered sweep type oscilloscope, it is possible to adjust the position or timing of starting of the waveform so that stable trigger (starting) pulses may be obtained.

Adjustment of starting (trigger) position

To move the triggering position to the section where changing waveforms are stable, adjust LEVEL knob ㊻ as shown below.





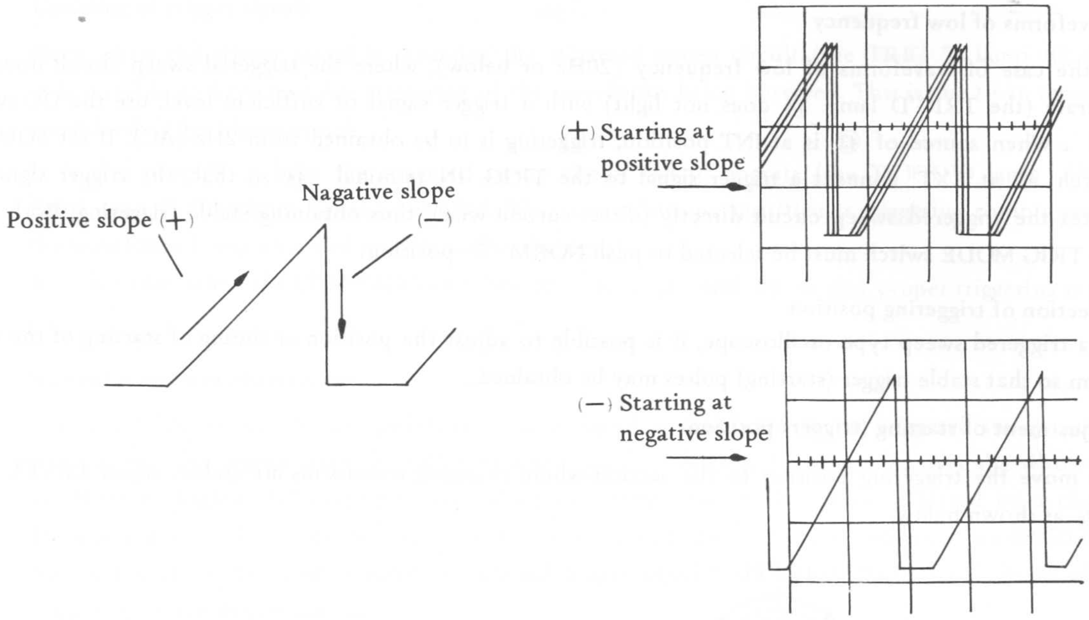
If noise is produced in the upper part of waveforms due to abnormal oscillation or the like, jittering may occur in the display.

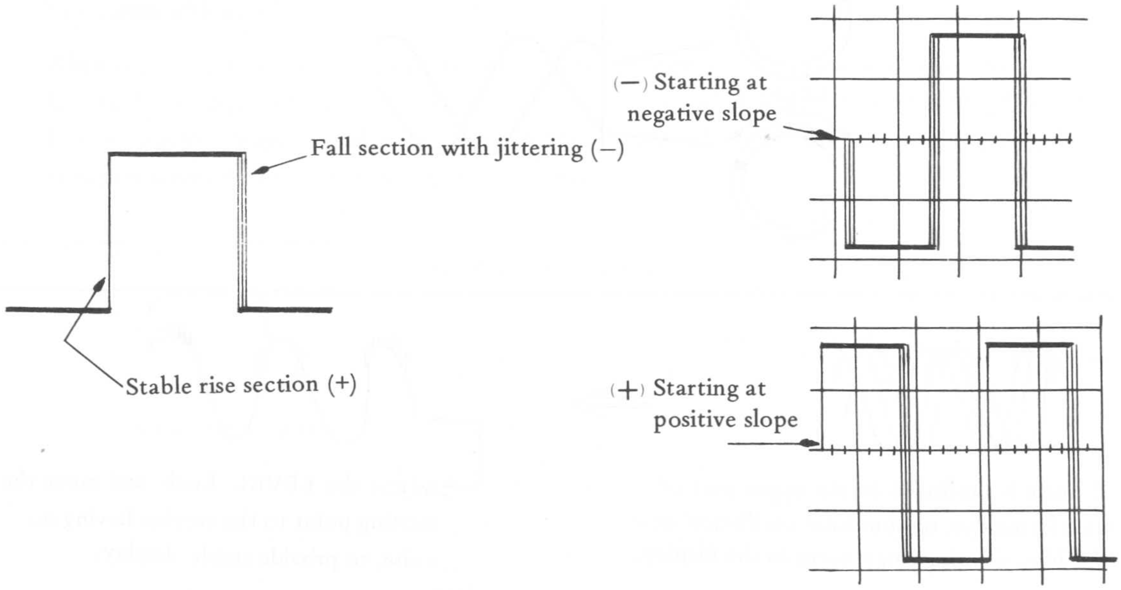
Adjust the LEVEL knob and move the starting point to the section having no noise, to provide stable display.

In the case of simple signals whose waveforms are not extremely asymmetrical, set the switch at PRESET. Then, triggering will take place almost in the center of the waveforms.

Selection of waveform slop (SLOPE +/–)

When the rise portion of the waveform is smooth and the fall section is steep, like a sawtooth wave, stable triggering can be obtained if starting (trigger) is performed in the fall portion. Also, in case of a square wave, especially when jittering is taking place. in the fall portion, stable triggering can be obtained if starting is performed in the rise portion. SLOPE switch ㊳ functions to select the slope (rise or fall section) of the starting (trigger) point of this trigger signal waveform.





6. Measurements

6-1 AC Peak Voltage

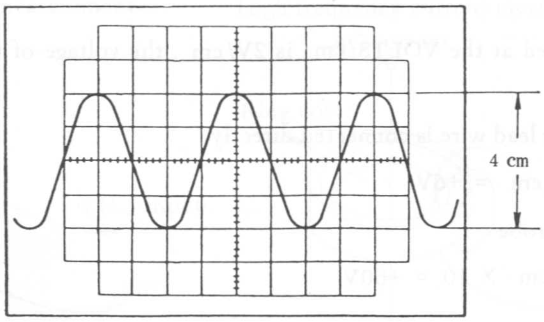
When it is desired to determine only the AC voltage component of the signal being measured, set AC-GND-DC switch ㉘ or ㉙ at AC. and, from the amplitude on the screen at this time, calculate the peak voltage as follows:

Measurement using a ×1 probe or lead wire

Peak voltage (Vp-p) = Value indicated at VOLTS/cm × amplitude (cm)

Measurement using a ×10 probe

Peak voltage(Vp-p) = Value indicated at VOLTS/cm × amplitude (cm) × 10



As shown above, the voltage of the signal being measured is calculated as follows:

If VOLTS/cm = 0.05V/cm ,

Peak voltage when a X1 probe or lead wire is connected directly = 0.05V/cm x4 cm . = 0.2Vp-p

Peak voltage when using a X10 probe = 0.05V/cm X 4 cm X 10 = 2Vp-p

If the input waveform is a sine wave, the measured voltage (p-p) can be converted to effective voltage (rms). The following relationship exists between the peak voltage (Vp-p) and the effective voltage (Vrms).

$$\text{Effective voltage (Vrms)} = \frac{\text{Peak voltage (Vp-p)}}{2\sqrt{2}}$$

2Vp-p, for instance, is converted to rms value as follows:

$$\frac{2\ \text{Vp-p}}{2\sqrt{2}} = \frac{2}{2 \times 1.414} = 0.707\ \text{Vrms}$$

Notes 1. When switch ㉘ or ㉙ is set at "AC," the low frequency characteristic is attenuated to –3dB at 2Hz. Also, note that no AUTO triggering is accomplished at 20Hz or less.

2. When measuring a voltage, be sure to turn the VARIABLE knobs ㉗ and ㉚ fully clockwise to ↻ CAL'D.

6-2 DC Voltage

Use AUTO sweep, set AC-GND-DC switch ㉘ or ㉙ at GND. The trace (bright line) should show OV. Set the trace to a position for easy measurement on the screen. Next, set the AC-GND-DC switch at DC and read the shift of the trace on the screen. Adjust the VOLTS/cm switch so that the trace will be displayed on the screen. An upward shift of the trace (bright line) represents (+) and a downward shift (–).

From the shift of the trace on the screen, the voltage of the signal being measured is calculated as follows:

voltage when a X1 probe or lead wire is connected directly

Voltage (V) = Value (V/cm) indicated at VOLTS/cm X shift (cm)

Voltage when using a X10 probe

Voltage (V) = Value (V/cm) indicated at VOLTS/cm X shift (cm) X 10

Example

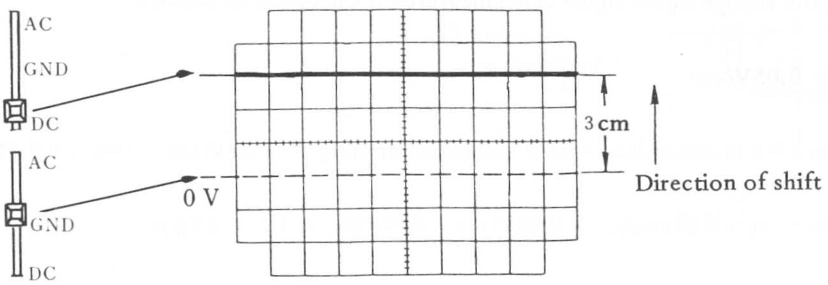
If the range indicated at the VOLTS/cm is 2V/cm, the voltage of the signal being measured is calculated as follows:

When a X1 probe or lead wire is connected directly

2V/cm X 3 cm = +6V

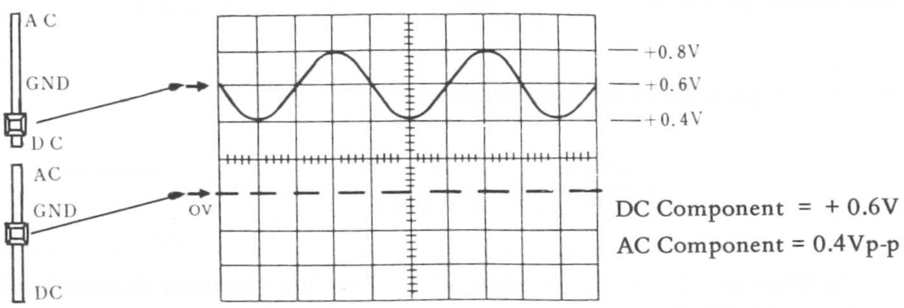
When using a X10 probe

2V/cm X 3 cm X 10 = +60V



6-3 DC + AC Peak Voltage

Make measurement using the "DC" and the "GND" as in the case of the measurement of DC voltage. If the range indicated at the VOLTS/cm is 0.1V/cm, the voltage of the signal being measured is obtained as shown below.



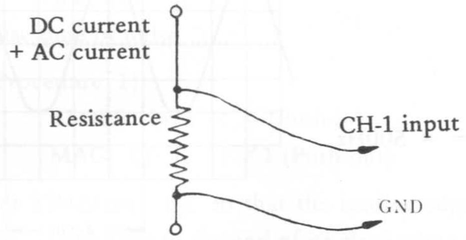
Note: When the DC component is much greater than the AC component, the waveform may be pushed off the screen making observation impossible. In this case, make measurements of the AC component and the DC component separately.

6-4 Current Measurement

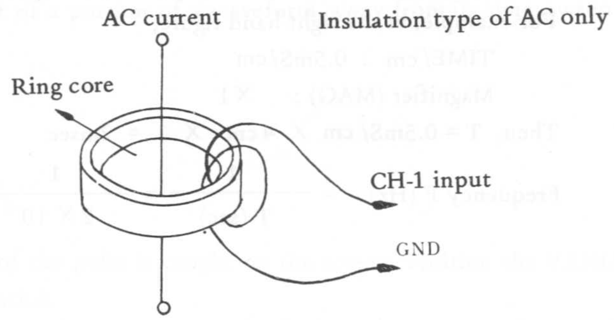
The voltage signal is the only phenomenon that can be observed by applying it to the oscilloscope directly. Accordingly, electric phenomena except for voltage, mechanical oscillation and all other phenomena must be converted into voltage and then applied to the input terminal.

When measuring current, insert known resistance into the circuit to be measured, observe a change is voltage across that resistance with an oscilloscope and convert it into current according to Ohm's law, that is E = IR, However, the resistance to be inserted must be within the range that causes no change in the operating condition of the circuit being measured.

Low frequency current measurement



High frequency current measurement



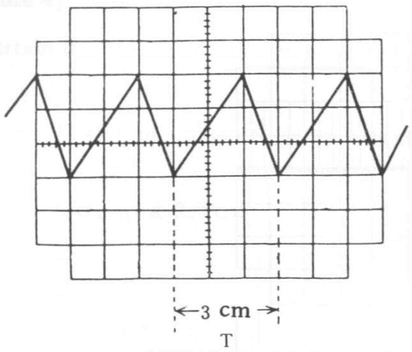
6-5 Time Interval Measurement

The time interval T is calculated as follows:

Time T (sec) = Value indicated at TIME/ cm X Distance on the screen X Reciprocal of magnification of the magnifier

The reciprocal of magnification of the magnifier is 1 when not magnified and 0.1 when magnified.

The time interval T in the left-hand figure is calculated as follows:



TIME/ cm = 0.5 (0.5mS/ cm)

When the magnifier is X1,

T = 0.5 mS/ cm X 3 cm X 1 = 1.5msec

When the magnifier is X10.

T = 0.5mS/ cm X 3 cm X 0.1 = 0.15msec

6-6 Frequency Measurement

There are two methods using waveforms to measure frequency. One is to calculate the frequency from the time of 1 period, and the second method is to count the number of complete waveforms, or pulses, over the 10 cm horizontal width.

As regards to first method, the time of 1 period, T, is measured as given in the Section 6-5 above, and its reciprocal is the frequency F.

$$\text{Frequency F (Hz)} = \frac{1}{\text{T (seconds)}}$$

$$= \frac{1}{\text{Value indicated at TIME/ cm} \times \text{distance of 1 period on the screen} \times \text{reciprocal of magnification of the magnifier}}$$

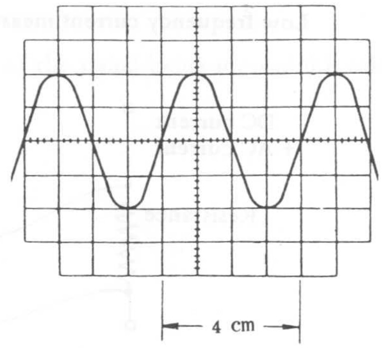
For example, in the right-hand figure,

TIME/ cm : 0.5mS/cm

Magnifier (MAG) : X1

Then, T = 0.5mS/ cm X 4 cm X 1 = 2msec

$$\text{Frequency F (Hz)} = \frac{1}{\text{T (sec)}} = \frac{1}{2 \times 10^{-3}} = 500\text{Hz}$$



As regards the second method, that is, counting the number of complete waveforms, or pulses, over the 10 cm horizontal width, the frequency is calculated as follows.

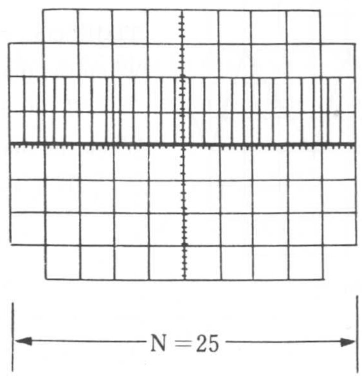
$$\text{Frequency F (Hz)} = \frac{\text{Number of pulses N}}{\text{Value indicated at TIME/ cm} \times \text{Reciprocal of magnification} \times 10\,\text{cm}}$$

Where, the reciprocal of magnification of the magnifier is 0.1 when magnified and 1 when not magnified.

For example, in the right-hand figure.

TIME/cm : 1μs/ cm

Magnifier : X1



Then,

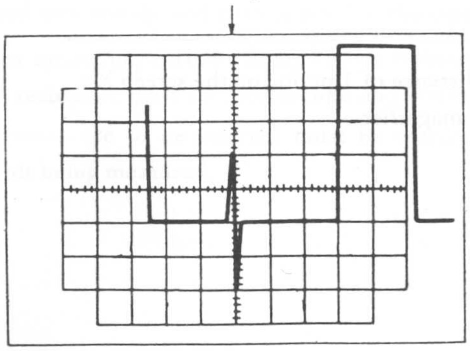
$$\text{Frequency F (Hz)} = \frac{25}{1\mu\,\text{sec/ cm} \times 10\,\text{cm} \times 1} = 2.5\text{MHz}$$

6-7 Rise Time of Pulse

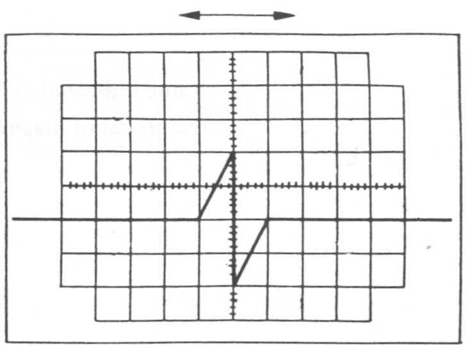
When making measurement of Rise Time, Horizontal magrification (MAG X 10)

Before measuring the rise time of a pulse, proper use of the magnifier will be described.

(1) Place the portion being observed on the center of the scale by means of the ⟷ knob.



(2) 10 times magnification to both sides.



As mentioned above, the magnifier is used for detailed observation of a portion of a waveform. This is especially convenient when the enlargement of a portion of a waveform, away from its sync. sweep starting point, is desired.

Rise time of pulse

(Procedure 1)

SLOPE ㊳ : – (Push-in)

MAG. ㊲ : X1 (Push-out)

Set TIME/cm ㊴ so that the leading edge of the pulse is caught on the screen. Position the VARIABLE ㊳ (red knob) to the end of its clockwise rotation.

(Procedure 2)

Position the pulse so that the flat portion is placed on the screen at a height with no fractional values, e.g. just 5 cm . (This is for easy calculation of 10% upper and lower deduction, when required.)

(Procedure 3)

Place the leading edge of the pulse on the center line of the scale by means of the horizontal positioning knob.

(Procedure 4)

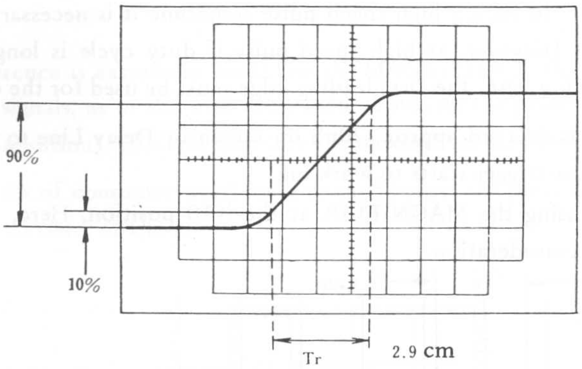
Make certain the MAGNIFIER is set at X10 (▬ : Push-in).

calculation of rise time

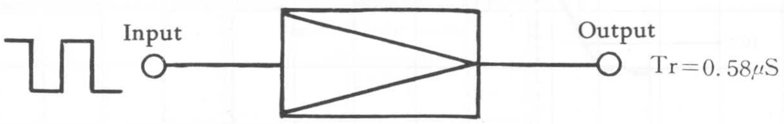
Tr = (TIME/cm range) X (Horizontal distance on the screen, cm) X (Magnification rate, 1/10)

Example

Tr = $2\mu s$/cm X 2.9 cm X 1/10 = $0.58\mu s$



On the basis of this rise time, Tr, the upper limit frequency of the amplifier, fc (–3dB), can be determined. For instance, on the assumption that the above measurement was performed with input pulses which were fast enough and that the value calculated represents the output waveform of the amplifier being tested, then the upper limit frequency, fc, of the amplifier can be found.



Amplifier being tested

$$Tr \leqslant \frac{\text{Tr of Output}}{10}$$

$$fc = \frac{0.35}{Tr} = \frac{0.35}{0.58 \times 10^{-6}} = 0.6 \times 10^{6} = 600\text{kHz}, \ (-3\text{dB})$$

Units of time are enumerated below for reference:

Millisecond; ms	=	10^{-3} Sec.
Microsecond; μs	=	10^{-6} Sec.
Nanosecond; ns	=	10^{-9} Sec.
Picosecond; ps	=	10^{-12} Sec.

In the measurement of a comparatively fast pulse, the rise time of the LBO-520 must also be taken into consideration.

Rise time of the LBO-520 : Ta = 0.0117μS.

Rise time of the output of the amplifier being tested : Ti

Rise time observed on the screen : Tr

With this data, the true rise time Ti is calculated:

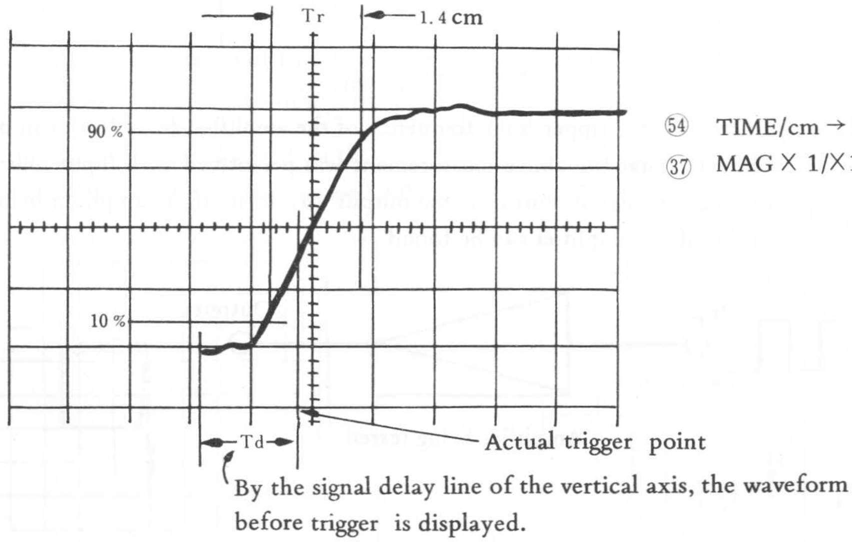
$$Ti = \sqrt{Tr^2 - Ta^2}$$

Observation of leading edge at maximum sweep speed

If duty cycle is short, leading edge can be observed easily on 0.2 μS/cm range or 20 nS/cm (MAG $\times$ 10) in spite of high speed pulse. In such a high speed pulse sometime it is necessary to take the Rise time of the Unit itself into account. However, at high speed pulse if duty cycle is long, the second leading edge goes out of the screen. In such a case, the first leading edge must be used for the observation.

Vertical amplifier signal is delayed approx. 20nS on screen by Delay Line to make it possible to observe the leading edge portion before trigger starts to work on.

The limit is displayed using the MAGNIFIER at the $\times$10 position. Here, the rise time of the LBO-520 must also be taken into consideration.



(54) TIME/cm → 0.2μS

(37) MAG $\times$ 1/$\times$10 → $\times$ 10

Ta; Rise time of the LBO-520 ≒ 0.35/30MHz ≒ 11.7nS

Tr; Rise time observed on the screen

$$Tr = 0.2\mu s/cm \times 1.4cm \times 1/10 = 28nS$$

Ti; True rise time of a pulse being measured

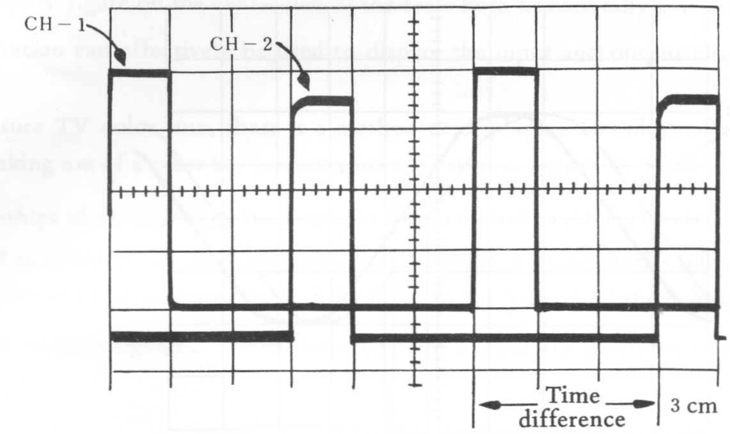
Thus, in the above example,

$$Ti = \sqrt{Tr^2 - Ta^2} = \sqrt{(28 \times 10^{-9})^2 - (11.7 \times 10^{-9})^2} = 25.44nS$$

6-8 Time Difference between Two Signals

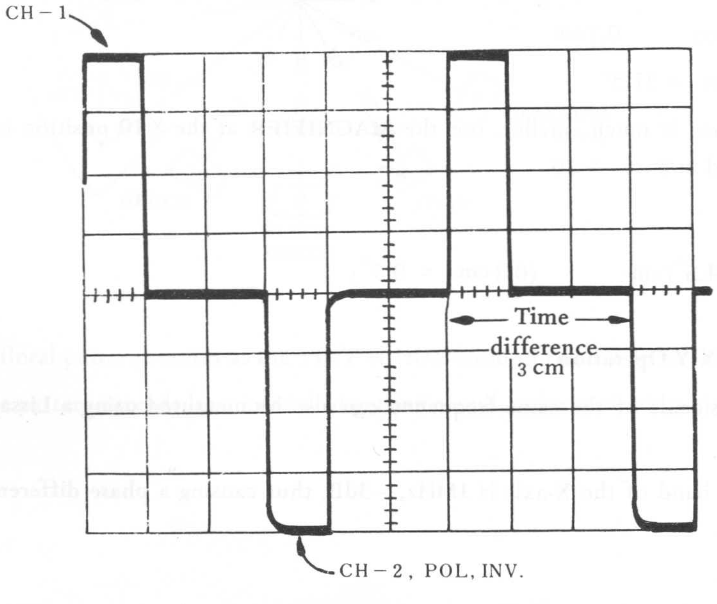
By making use of the dual trace advantage, it is possible to measure a time difference between two signals. The adoption of a fixed trigger system in CH-1 or CH-2 permits measurement of the time difference without error even at ALT or CHOP.

When TRIG. ㉓ is set at ▙ CH-1, it is possible to measure a delay time difference of CH-2 on the basis of the signal of CH-1.



When this time difference is extremely small, use the MAGNIFIER at the ×10 position. If it is troublesome to superimpose two signals, as in the case illustrated above, set the polarity inversion switch of CH-2 ㉒ at INV, then use ADD (addition). This will facilitate the measurement as shown in the following figure.

In case of a pulse train of computer word pulse or the like, set the polarity inversion switch of CH-2 at INV. to identify the signal of CH-1 or CH-2.



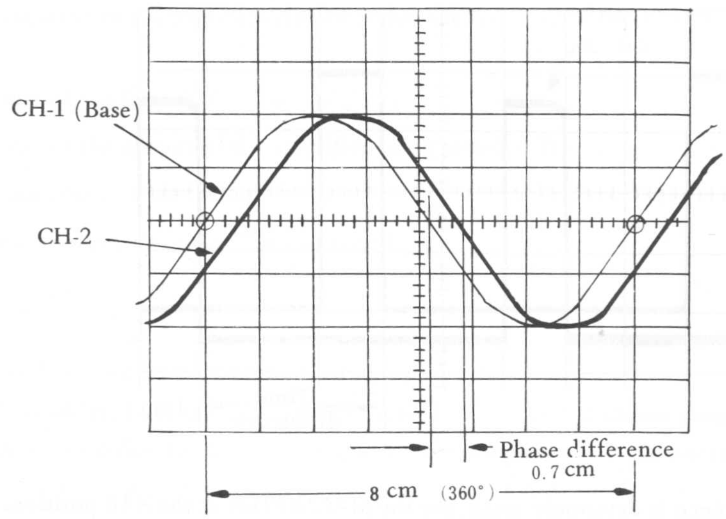
6-9 Phase Difference between Two Signals

To measure a phase difference between two signals of the same frequency, the dual trace display system can be utilized up to the upper limit frequency of the amplifier.

First, position both signals on the center line of the scale, e.g. just 4cm, as shown in the following figure by means of the VARIABLE and horizontal positioning knobs.

Next, set the distance where the center of the waveform of the base channel intersects with the center of the scale to 8cm horizontally.

If difficulty is encountered in properly displaying the phase difference as shown in the following figure because it (phase difference) is too large, use the polarity inversion switch of CH-2 and move the phase by 180° beforehand, and then display the phase difference. After that, this 180° should be taken into account.



As shown in the above figure, set 1 cycle, 360° to 8cm Then, $\frac{360^\circ}{8\,\text{cm}} = 45^\circ/\text{cm}$

Accordingly, the phase difference in the above example can be calculated as follows:

Horizontal distance on the screen: 0.7cm

Phase difference = 45°/cm X 0.7cm = 31.5°

If the portion of the phase difference is much smaller, use the MAGNIFIER at the X10 position in the above setting. At this time, 360° is displayed in 8cm X 10.

Then,

$$\frac{360^\circ}{8\,\text{cm} \times 10} = 4.5^\circ/\text{cm} \qquad (0.2\,\text{cm} = 0.9^\circ)$$

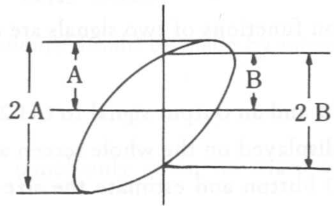
6-10 Measurement of Phase Difference by X-Y Operation

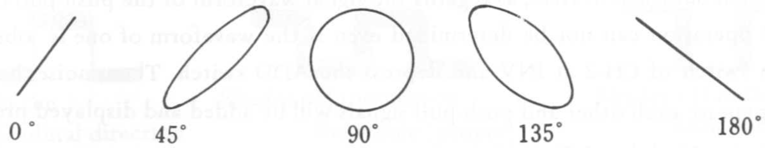
The phase difference between two signals of the same frequency can also be measured using a Lissajous' figure by X-Y operation.

In this case, however, the frequency band of the X-axis is 1MHz, –3dB, thus causing a phase difference of 3° or less at 100kHz between X and Y.

$$\sin\theta=\frac{B}{A}=\frac{2B}{2A}$$

$$\theta=\sin^{-1}\frac{B}{A}$$





Place the Lissajous' figure on the center line of the scale both horizontally and vertically.

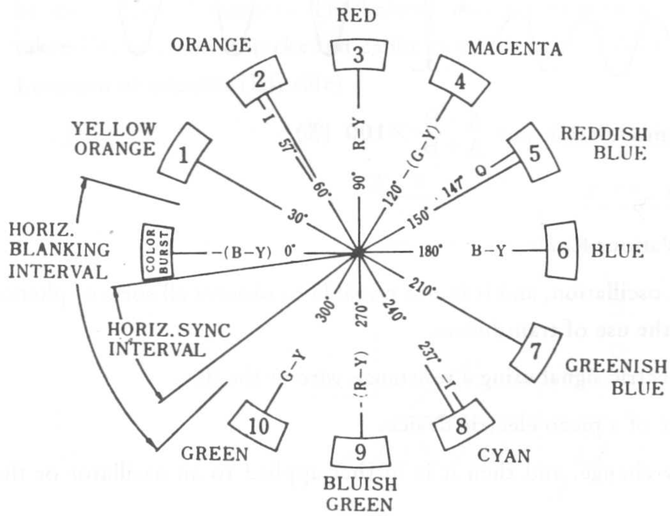
This X-Y operation can effectively be used to display the input and output characteristics of all kinds of electric circuits.

Also, to measure TV color hue, there is a method of displaying 10 colors of the gated rainbow pattern by X-Y operation (making use of a color bar pattern generator such as LEADER Model LCG-395A).

Phase relationships of the gated rainbow signal

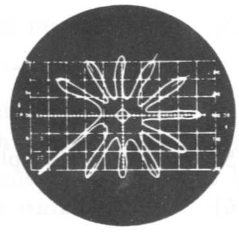
The ten gated rainbow signals have the phase relationships as shown in the following figure. The color tint pattern (VECTOR) is obtained by applying the B-Y SIGNAL to the X-axis and the R-Y SIGNAL to the Y-axis.

Feed the gated rainbow signals obtained from the color bar pattern generator to the color TV set.



The floral pattern rotates as the TINT or HUE knob of the TV set is turned.

If the pattern spreads long instead of getting round, color saturation is responsible.



Vector pattern

6-11 Measurements of Error between Two Signals and Push-Pull Signal

If the addition and subtraction functions of two signals are utilized, error and push-pull waveforms can properly be displayed.

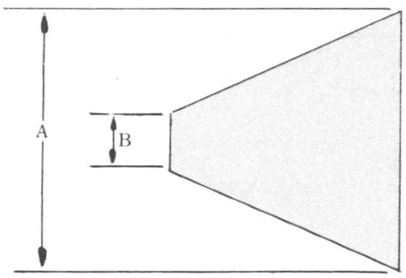
Apply an input signal to CH-1 and an output signal to CH-2 and set CH-2 POL. (polarity) so that the waveforms of the same amplitude may be displayed on the whole screen as far as possible; these signals may be out of phase with each other. Depress the ADD button and estimate the size of the remaining waveform and the condition of waveform distortion when subtracted. Also, as regards the signal waveform of the push-pull circuit, the condition of the original push-pull operation can not be determined even if the waveform of one is observed sepearately. Set the polarity inversion switch of CH-2 at INV and depress the ADD switch. Then, noise, hum and other in-phase components will compensate each other and push-pull signals will be added and displayed properly.

6-12 AM, SSB Transmission Modulated Wave Measurement

When observing modulation distortion or the like by providing triggering to the envelope of amplitude modulated waves (SSB/DSB), apply voice waves to external triggering or apply a modulation envelope of high frequency to CH-2 if the sensitivity is insufficient, to trigger CH-1.

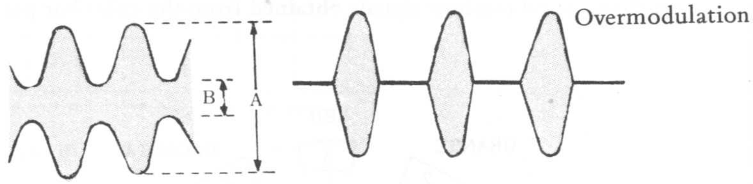
In the use of the trapezoid display, it is possible to confirm the linearity of modulation irrespective of modulated voice waves.

For trapezoid display, perform the aforementioned X-Y operation and apply voice waves to the X-axis of CH-1 and high-frequency waves to the Y-axis of CH-2.



Trapezoid display

AM (Amplitude) modulated wave



Degree of modulation $m = \frac{A-B}{A+B} \times 100$ (%)

6-13 Description of Applications by Transducers of Various Kinds

The oscilloscope is intended to observe electric oscillation, and it is also possible to observe all sorts of phenomena if they can be converted into electric signals by the use of transducers.

1) A change in tension is converted into an electric signal using a resistance wire or the like.
2) A change in pressure is observed by the use of a piezo-electric device.
3) Displacement is converted into a capacity change, and then it is further applied to an oscillator or the like and observed as a change in frequency.
4) A magnetic variation is observed using a magnetostriction device.
5) An optical displacement is observed using a photo transducer.
6) A temperature change is observed using a thermistor or thermocouple.

Besides all these mentioned above, many studies have been made on sensors recently, and it is suggested that reference be made to technical books.

7. MAINTENANCE AND CALIBRATION BY THE USER

The following performance checks and internal adjustments should be made by means of an insulated screw driver (about 2mm) from outside without opening the cabinet.

7-1 ⊘ ASTIG. (Astigmatism)

Adjust the ⊘ ASTIG. knob ⑬ on the front panel only when no sharp waveform can be obtained with the FOCUS knob alone.

The astigmatism can approximately be determined by the extent of shading off when the FOCUS knob is greatly shifted. As shown in the above figure, the waveform should shade off at the same ratio on the whole.

Meanwhile, some shade may remain around the screen dependent upon the properties of the CRT section (screen) mounting.

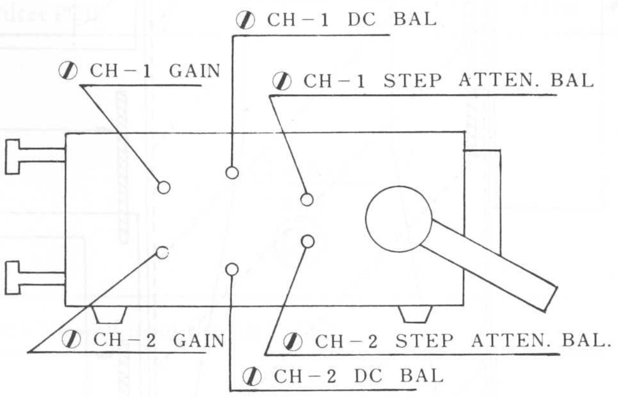
Adjustment of the spot may burn the fluorescent screen, so care should be exercised to use minimum brightness for short periods of time.

7-2 ⊘ ROTATION (Trace Slope)

Adjust the ⊘ ROTATION (beam rotation) knob on the front panel when slight tilting of the traces is caused by the effect of the external magnetic fields. Make certain that tilting of the traces is not caused by the effect of unusually strong external magnetic fields due to the position of the oscilloscope.

When making these adjustments, the AC line voltage should be within ±3% of the rated voltage and a warmup should be more than 30 minutes. The balance adjustment is made with consideration of variations in ambient temperature taken into account. Checks and calibrations, therefore, should be made at a room temperature of about 15 to 25°C.

Location of adjuster (left side)



7-3 Vertical Gain

⊘ CH-1 GAIN and ⊘ CH-2 GAIN should be calibrated in the same range for both channels. Especially, in dual trace operation, adjustment should be made in such a way as to produce no sensitivity difference between channels.

(Example)

Set both CH-1 and CH-2 at 0.1V/cm and DC, and turn the VARIABLE knob to the CAL'D position. Then, apply square waves, 0.5Vp-p, of the LBO-520 to both input terminals, to provide dual trace display. Adjust ⊘ CH-1 GAIN and ⊘ CH-2 GAIN so that both waveforms will show 5cm and coincide with each other.

7-4 Vertical Step Attenuator Balance

Adjust ⊘ CH-1 STEP ATTEN. BAL. and ⊘ CH-2 STEP ATTEN. BAL. if the vertical position moves when the VOLTS/cm knobs ㉖ and ㉛ are switched, for both channels.

With the switch at AUTO, let a horizontal trace appear on the screen and set the VOLTS/cm switch at 20mV/cm . Then, set the vertical position at this time to the center of the screen. (VARIABLE → CAL'D) Next, set the switch at 50mV/cm . If the position moves unnecessarily at this time, set it to the center of the scale by means of STEP ATTEN. BAL. of CH-1 and CH-2.

Make repeated adjustments in the range of 50mV/cm so that it will agree with the position of 20mV/cm .

7-5 Vertical Variable Balance

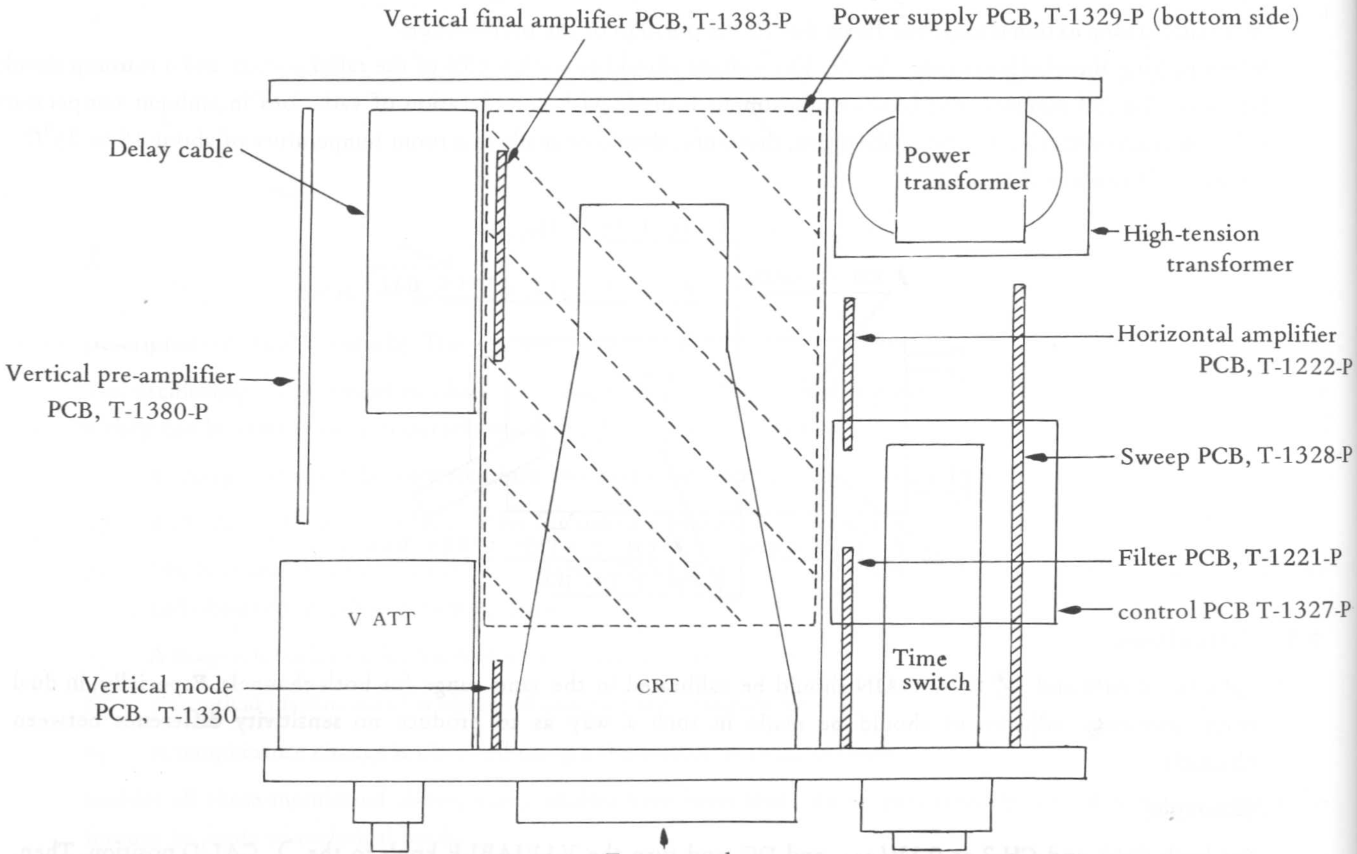
Adjust ⊘ CH-1 DC BAL. and ⊘ CH-2 DC BAL. if the vertical position moves when the VARIABLE knobs ㉗ and ㉚ are turned. (㉘ , ㉙ → GND) With the switch at AUTO, let a horizontal trace appear on the screen and turn the VARIABLE knob fully counterclockwise. Then, set the vertical position at this time to the center of the screen. (VOLTS/cm → 20mV/cm or other constant range)

Next, turn the knob fully clockwise. If the position moves a large amount at this time, set it to the center of the scale by means of DC BAL. of CH-1 and CH-2.

7-6 Additional Calibration Procedures

Note that only a qualified person should be allowed to touch the internal adjusters described herein. Care must be exercised not to open the outer case unnecessarily because high voltage, 6000/1200V, is produced inside.

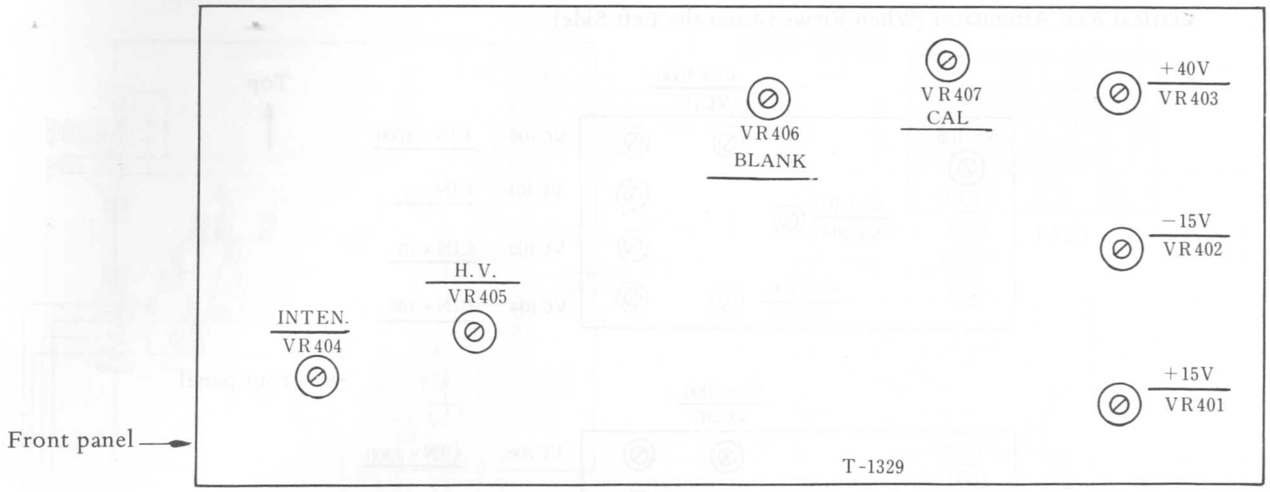
Withdraw the plug and open the outer case carefully and allow the instrument to stand a few minutes until internal charge is discharged.



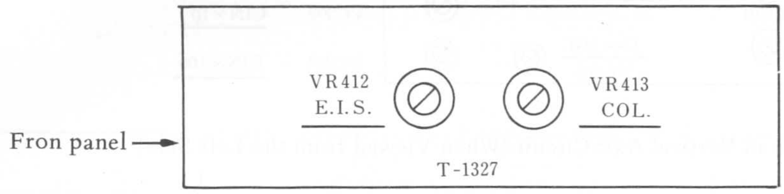
7-6-1 Arrangement Diagram of Principal Components (Top View)

Adjusting trimmers and parts numbers are printed in letters and-symbols on the P.C. Board.

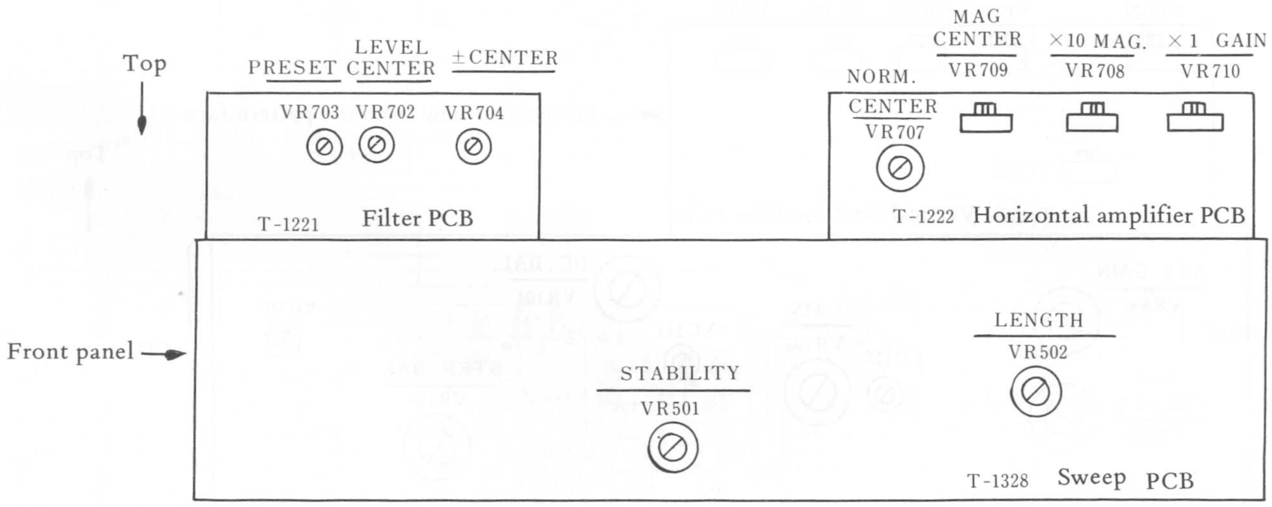
7-6-2 Location of Adjusters on Power Supply PCB (When Viewed from the Back Side of the Main Body)



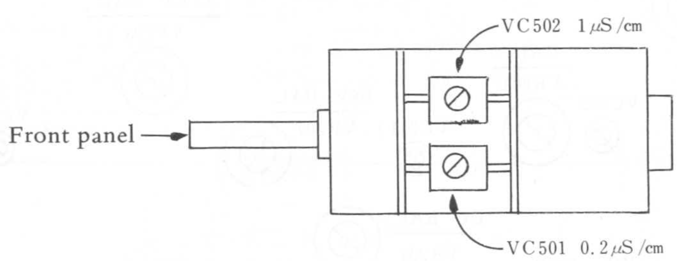
CRT control PCB (When Viewed from the Upper Side)



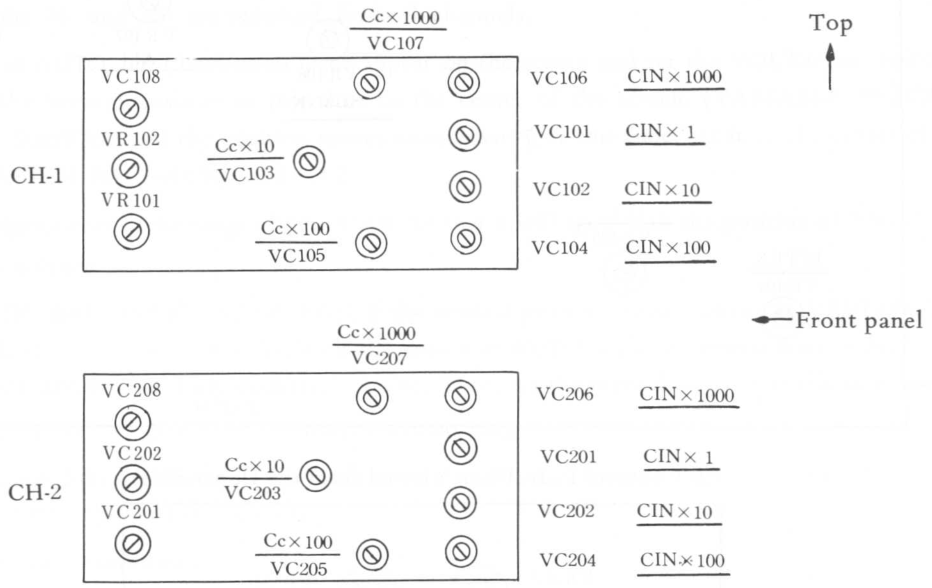
7-6-3 Location of Adjusters in Sweep Circuit (When Viewed from the Right Side)



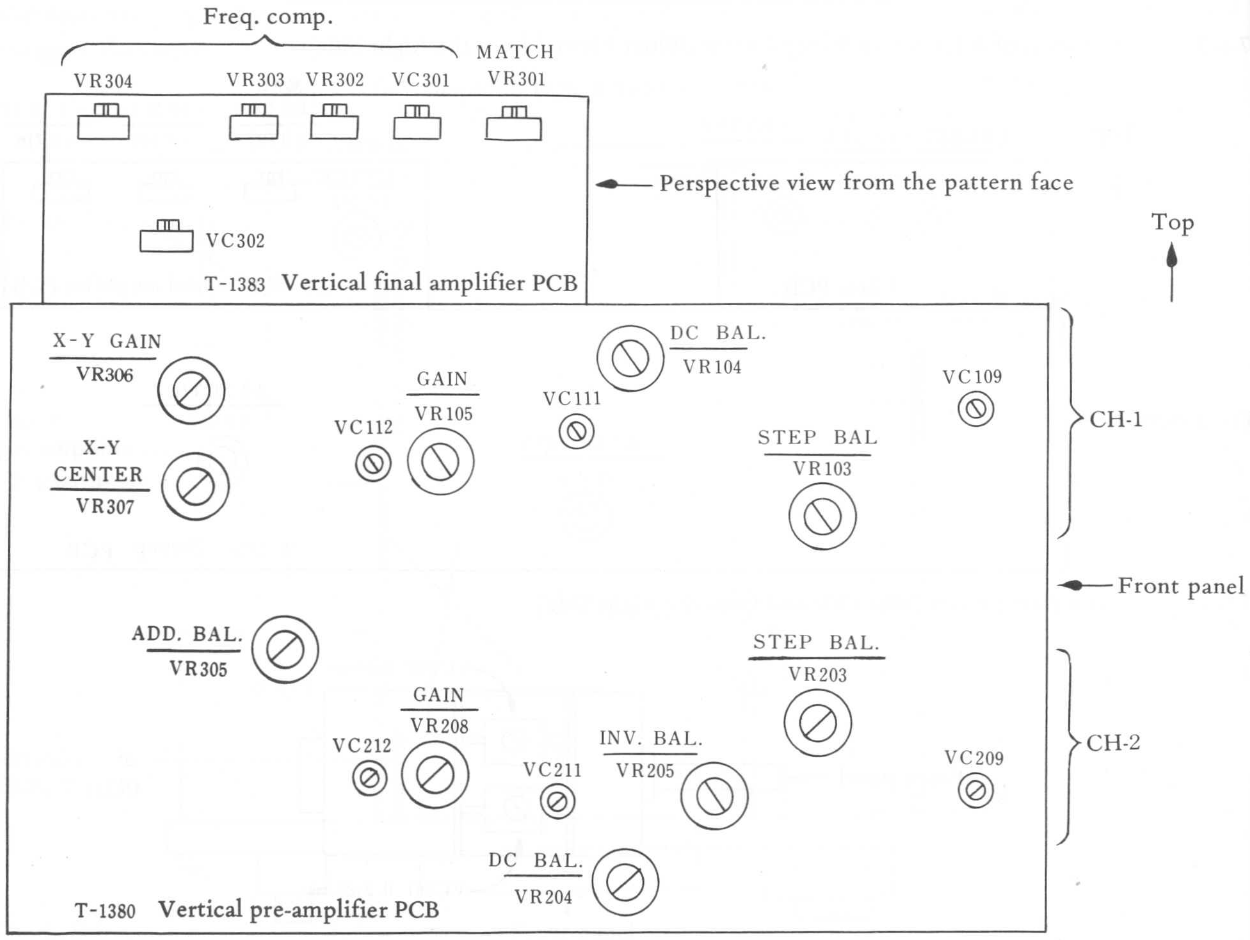
7-6-4 Time Base Switch (When Viewed from the Right Side)

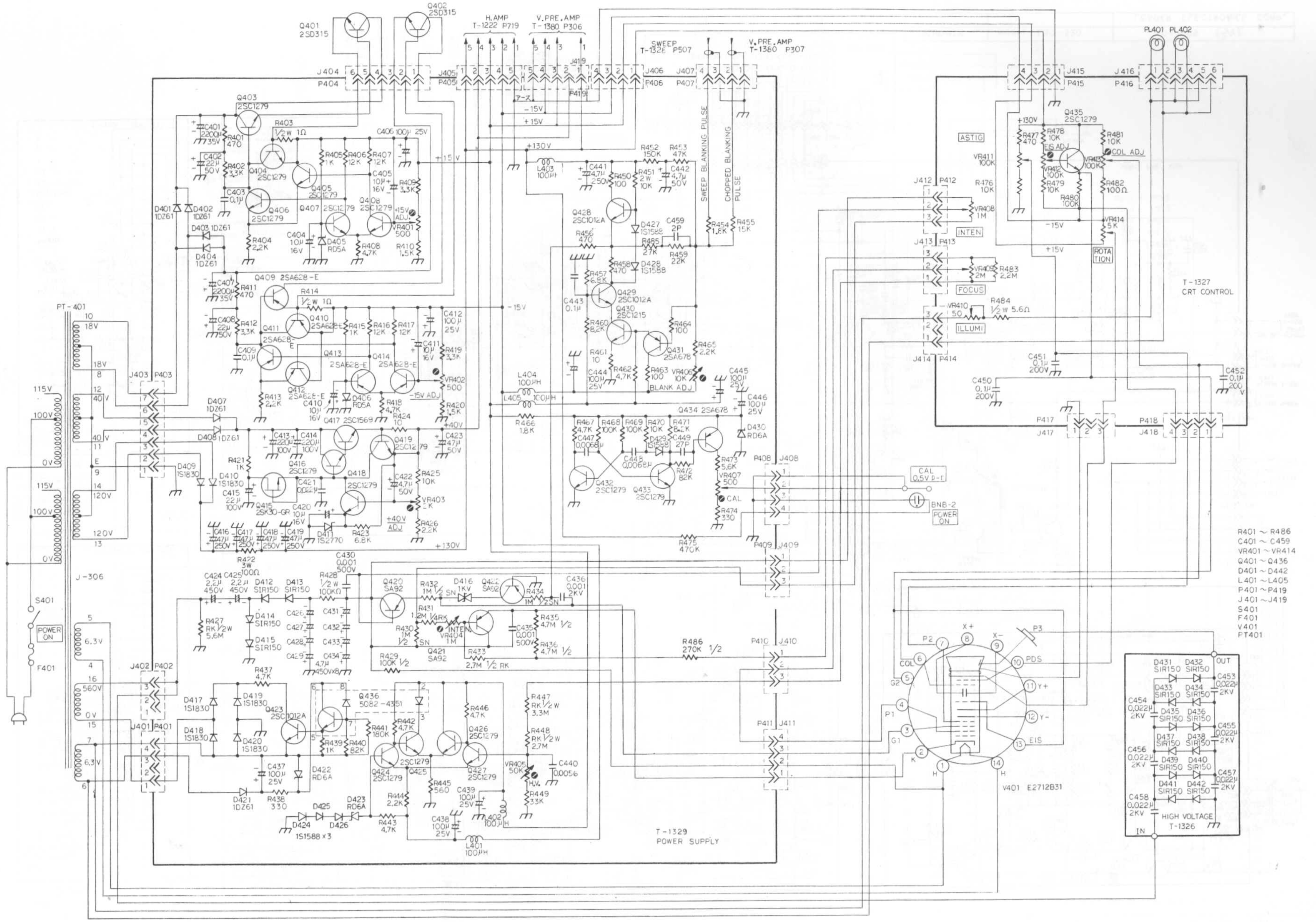


7-6-5 Vertical Axis Attenuator (When Viewed from the Left Side)

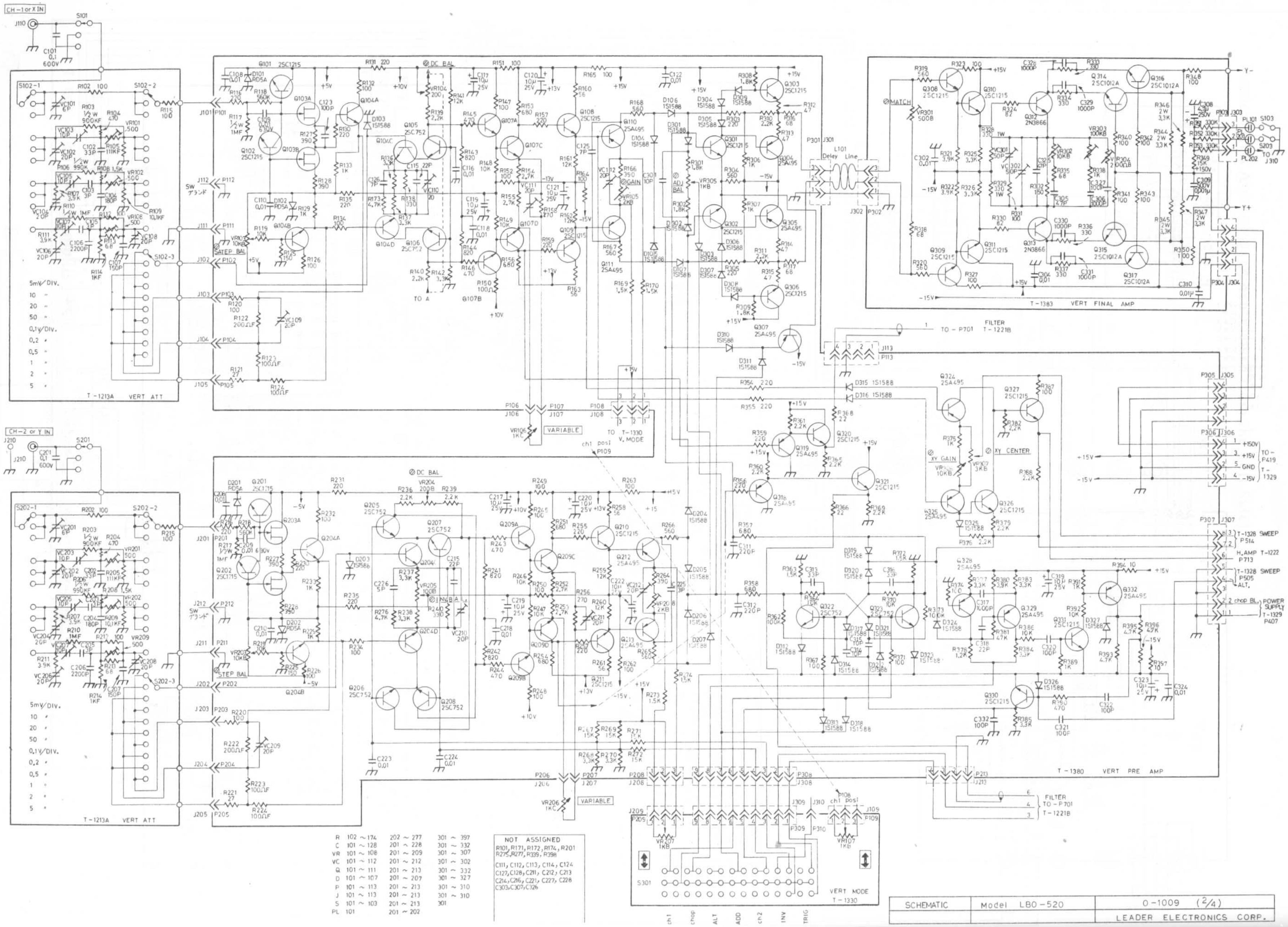


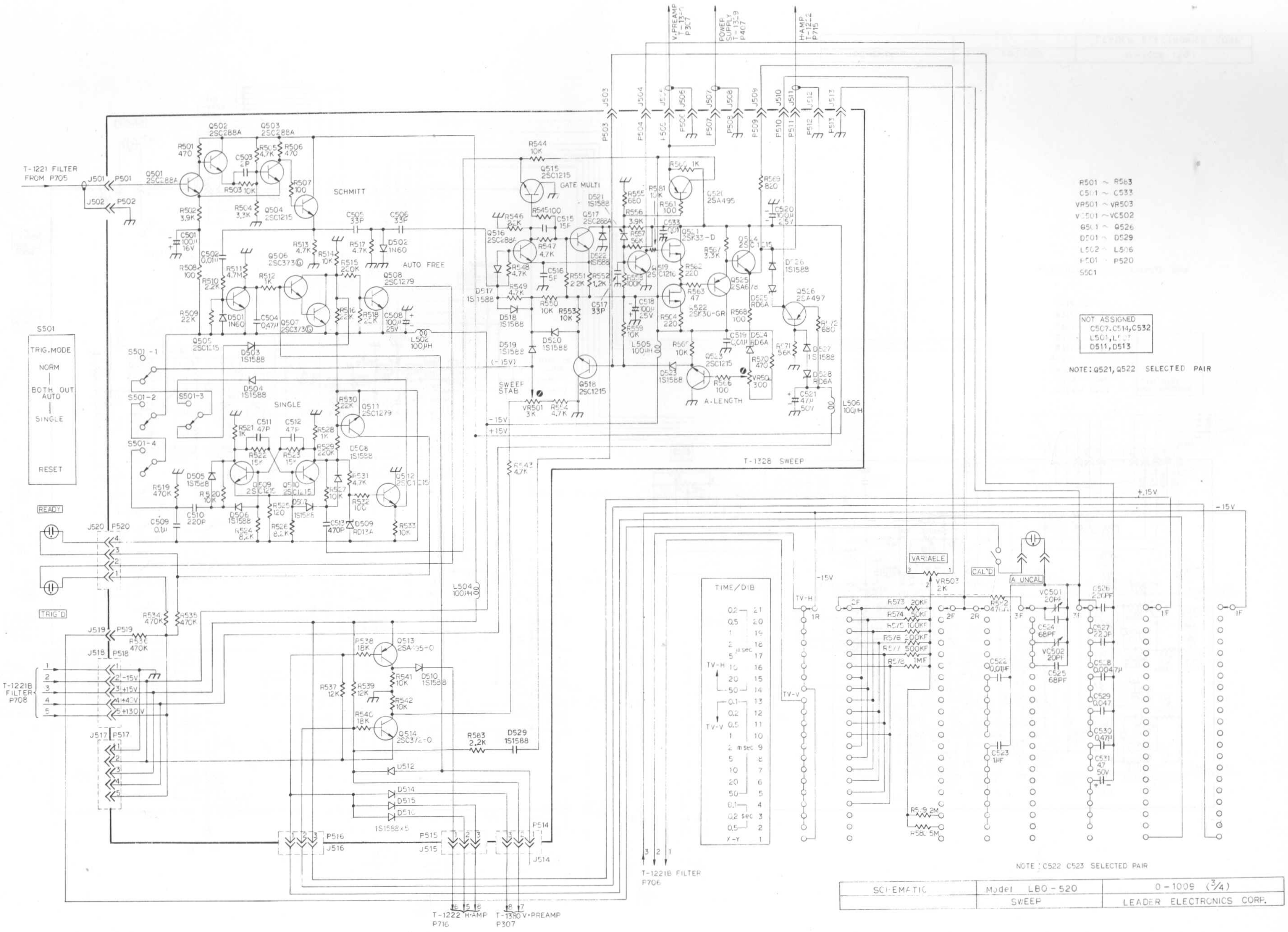
7-6-6 Location of Adjusters in Vertical Axis Circuit (When Viewed from the Left Side)



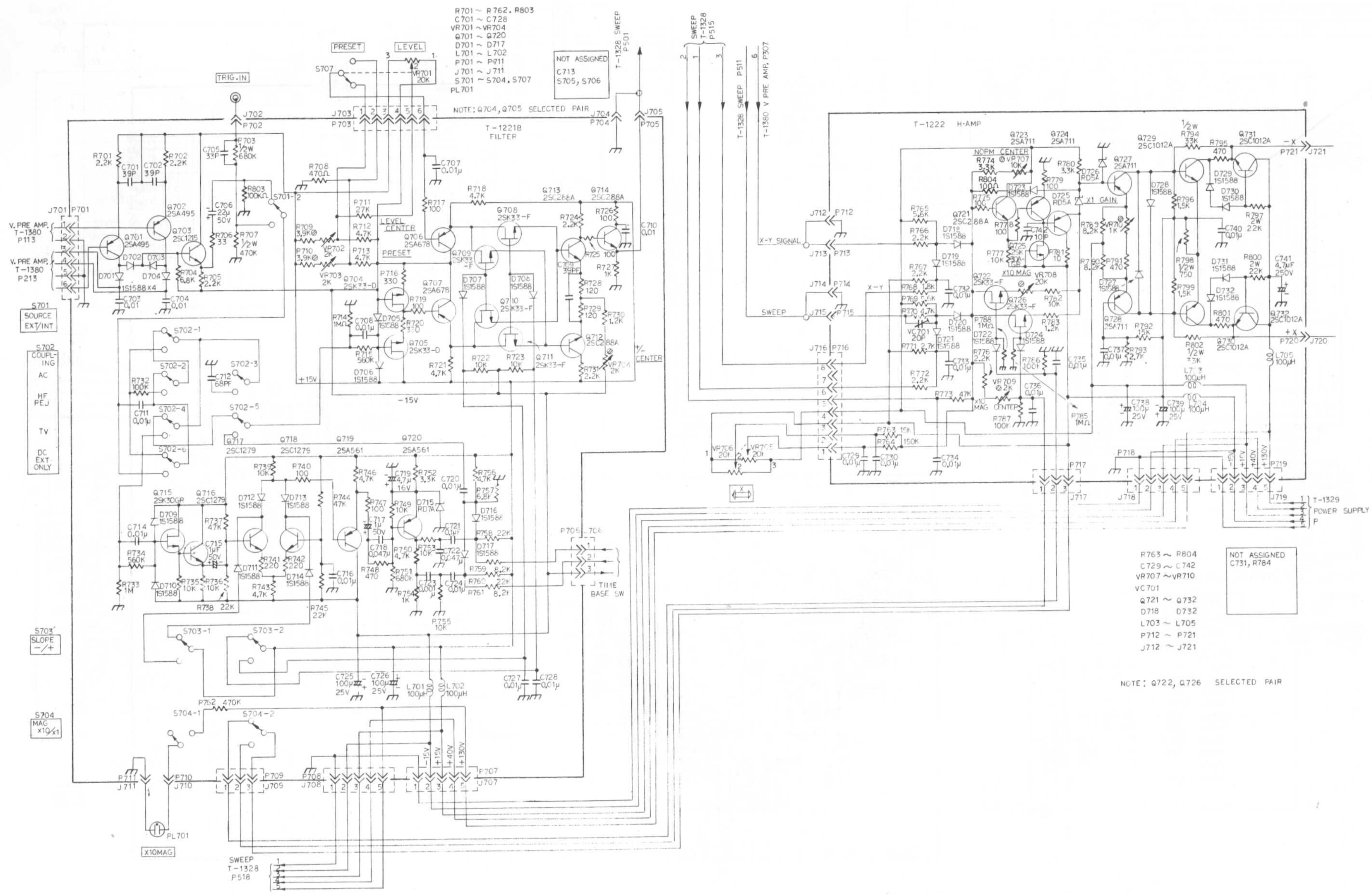


SCHEMATIC	Model LBO-520	0-1009 (1/4)
		LEADER ELECTRONICS CORP.


CH-1 or X IN
CH-2 or Y IN
T-1213A VERT ATT
T-1383 VERT FINAL AMP
T-1380 VERT PRE AMP
VERT MODE T-1330
FILTER TO-P701 T-1221B
DC BAL
STEP BAL
VARIABLE
XY GAIN
XY CENTER
MATCH
Delay Line
5mV/DIV.
10
20
50
0.1V/DIV.
0.2
0.5
1
2
5
ch1
chop
ALT
ADD
ch2
INV
TRIG
T-1328 SWEEP P514
H.AMP T-1222 P713
T-1328 SWEEP P505
POWER SUPPLY T-1329 P407
R 102 ~ 174 202 ~ 277 301 ~ 397
C 101 ~ 128 201 ~ 228 301 ~ 332
VR 101 ~ 108 201 ~ 209 301 ~ 307
VC 101 ~ 112 201 ~ 212 301 ~ 302
Q 101 ~ 111 201 ~ 213 301 ~ 332
D 101 ~ 107 201 ~ 207 301 ~ 327
P 101 ~ 113 201 ~ 213 301 ~ 310
J 101 ~ 113 201 ~ 213 301 ~ 310
S 101 ~ 103 201 ~ 213 301
PL 101 201 ~ 202
NOT ASSIGNED
R101, R171, R172, R174, R201
R275, R277, R339, R398
C111, C112, C113, C114, C124
C127, C128, C211, C212, C213
C214, C216, C221, C227, C228
C303, C307, C326
SCHEMATIC
Model LBO-520
0-1009 (2/4)
LEADER ELECTRONICS CORP.



SCHEMATIC	Model LBO-520	0-1009 (3/4)
	SWEEP	LEADER ELECTRONICS CORP.



SCHEMATIC	Model LBO-520	0-1009 (4/4)
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